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An optimization model for Army planning and programmin

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THESIS

AN OPTIMIZATION MODEL FOR
ARMY PLANNING AND PROGRAMMING

by

Cpt. Scott F. Donahue
September 1992

Thesis Advisor Richard E. Rosenthal

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A major goal of the United States Army modernization strategy is to improve its warfighting capabilities. In executing its mission as the architect of the future Army, the Training and Doctrine Command (TRADOC) has used a heuristic capital allocation algorithm to recommend which candidate Army modernization actions to fund in the development of the Long Range Army Materiel Requirements Plan (LRAMRP). The goal of this thesis is to develop a flexible, responsive, multi-objective, optimization model to replace the existing heuristic capital allocation algorithm. This model maximizes potential warfighting benefits derived from competing Army candidate modernization actions subject to multiple national and Department of the Army goals and constraints. Additionally, this study demonstrates the fast prototyping capability of a weighted, goal programming approach to a multiple objective capital budgeting problem formulated with the General Algebraic Modeling System (GAMS). The model will be implemented by the Army's TRADOC Analysis Command (TRAC) Operations Analysis Center (OAC) as a tool in designing overall optimal Army investment strategies.

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AN OPTIMIZATION MODEL FOR ARMY PLANNING AND PROGRAMMING

by

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Captain, United States Army
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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

A major goal of the United States Army modernization strategy is to improve its warfighting capabilities. In executing its mission as the architect of the future Army, the Training and Doctrine Command (TRADOC) has used a heuristic capital allocation algorithm to recommend which candidate Army modernization actions to fund in the development of the Long Range Army Materiel Requirements Plan (LRAMRP).

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THESIS DISCLAIMER

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

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I. INTRODUCTION

In June of 1991 the Naval Postgraduate School Operations Research Department was formally enlisted to develop an optimization model that could be used as a tool in designing overall Army investment strategies. The model would be used in prioritizing candidate Army modernization actions in the development of the Long Range Army Materiel Requirements Plan (LRAMRP) and would replace the heuristic capital allocation algorithm currently used by the Army's Training and Doctrine Command (TRADOC). The projected earliest need for the model was October of 1992 for implementation in the LRAMRP 96-10 cycle.

A. PROBLEM STATEMENT

The goal of this thesis is to develop a flexible, responsive, multi-objective, optimization model that assists in the selection of a set of competing Army modernization actions (known as *management decision packages* or MDEPs) that maximize potential warfighting benefits, subject to multiple national and Department of the Army goals and objectives.

B. SCOPE

This study demonstrates the fast prototyping of a weighted, goal programming approach to a multiple objective capital budgeting problem formulated with the General Algebraic Modeling System (GAMS) [Ref. 1]. The optimization model is designed to run on standard Army desktop computers (i.e., 386/486 processors) and will be implemented by the Army's TRADOC Analysis Command (TRAC) Operations Analysis Center (OAC) as a tool for designing overall Army investment strategies across a fifteen year programming horizon. Funding and experimental data for this research effort were provided by TRAC-OAC, Combined Arms Analysis Directorate (CAAD), Fort Leavenworth, Kansas.

C. BACKGROUND

1. Scale of the Problem

Each fiscal year the Department of Defense (DoD) is allocated approximately $300 billion dollars. The Army's share of the DoD total obligation authority (TOA) is approximately $70 billion dollars, of which it currently invests approximately 16% into research, development, and acquisition (RDA) [Ref. 2: pp. 2-4, 3]. The Army's TRADOC currently manages about 75% of the total Army RDA projects under consideration, resulting in an annual RDA budget ceiling of approximately $8 billion dollars. This corresponds to an investment exceeding $120 billion dollars across a fifteen year programming cycle that must be wisely allocated among more than 250 competing modernization candidate projects. [Ref. 3]

2. Operating Environment

a. The Army Modernization Strategy

The objectives of the 21st century Army focus on a strategically, operationally, and tactically mobile force that will be well-equipped, well-trained, and capable of rapidly deploying worldwide to fight and win in any environment, against any enemy [Ref. 4]. Hence, a major goal of the United States Army modernization strategy is to improve its warfighting capabilities. This strategy is designed to equip the Army to execute its responsibilities under the national security strategy of the United States through versatility, deployability, lethality, and expansibility [Ref. 4]. In the wake of unprecedented force reductions, base closures, realignments, and reduced allocation of national resources to the military, the size of the future Army will be significantly smaller, mandating a higher priority for research and development activities that *maximize* the warfighting value of each investment dollar spent.

b. TRADOC'S Role as the Architect of the Future Army

In executing its role as the architect of the future Army, TRADOC represents the battlefield user in the long-range planning and programming of resources. Hence, it is the proponent for recommending an Army long-term investment strategy for resolving shortfalls in warfighting capability. TRADOC and subordinate commands identify weaknesses to be overcome and/or doctrinal and organizational initiatives that need to be supported, and then, creates a future vision of how to fight. Further elaboration on how TRADOC develops and shapes the Army's modernization strategy will be accomplished, for this portion of the study, through an examination of the evolutionary process used during the TRADOC FY94-08 planning and programming cycle.

c. The Concept Based Requirements System (CBRS)

The Concept Based Requirements System (CBRS) is the primary system used by TRADOC in executing its mission as architect of the future Army [Ref. 4]. By prioritizing warfighting needs and modernization actions, and developing an integrated strategy to achieve future vision, it provides the basis for identifying and synchronizing doctrine, training, leader development, organization, and materiel requirements for the Army [Ref. 5]. The TRADOC Analysis Command's Operations Analysis Center (OAC), the sponsor for this thesis, has provided analytical decision support for the last two programming cycles (i.e., FY92-06 and FY94-08), as part of the CBRS, in the development of the major CBRS products: the Battlefield Development Plan (BDP), the Army Modernization Memorandum (AMM), and the LRAMRP. This support has primarily been in assessing warfighting values associated with candidate modernization actions using the Analytic Hierarchy Process (AHP) and implementing a heuristic capital allocation algorithm to recommend a set of modernization actions that maximize warfighting value to the Army within available resources. Both of these analytical techniques are explained in Chapter II.

The CBRS is a two year process that begins with top-down guidance from Headquarters, TRADOC, providing a general overview of the modernization strategy and any specific considerations for the fifteen year planning and programming cycle (i.e., FY94-08, FY96-10, etc.) and ends with the publication of the LRAMRP. Once the LRAMRP is approved by TRADOC, the document becomes the basis for the Headquarters, Department of the Army (HQDA) Long Range Research, Development, and Acquisition Plan (LRRDAP), which stabilizes the Army modernization program and clearly defines the Army materiel investment strategy and priorities throughout the Planning, Programming, Budgeting, and Execution System (PPBES). The LRRDAP is the basis for the RDA (materiel modernization) portion of the Program Objective Memorandum cycle under consideration. [Ref. 6] Two prior products are published by TRADOC during the CBRS cycle. These are the Battlefield Development Plan (BDP) and the Army Modernization Memorandum (AMM), which form a foundation for subsequent LRAMRP development. The timeline for the CBRS cycle 94-08 is shown in Figure 1.

(1) Battlefield Development Plan (BDP). The Battlefield Development Plan for the fifteen year programming cycle under consideration is the initial product of the CBRS that identifies and prioritizes the Army's warfighting needs and capability issues "... based on the current and projected threat, global potential for conflict, and the Airland Battle Future concept which has evolved into the Airland Operations umbrella concept." [Ref. 4] For the past two programming cycles, establishing the BDP has been a fundamental aspect of the CBRS in charting the Army's modernization investment strategy.

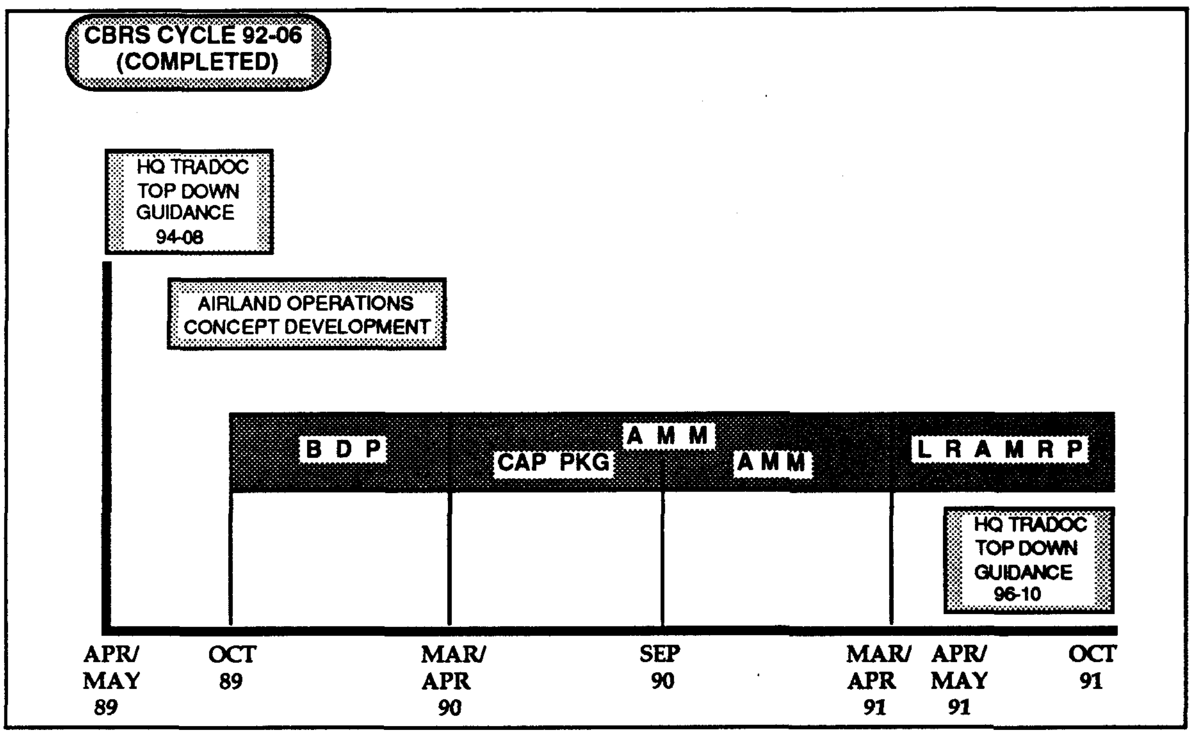

Figure 1. CBRS Cycle 94-08

(2) Army Modernization Memorandum (AMM). The subsequent CBRS product, the Army Modernization Memorandum, is TRADOC's vision of the future Army and "... is the CBRS product that presents a comprehensive, constrained strategy for closing the gap between base and required capabilities." [Ref. 4] It provides an integrated, total force modernization strategy by recommending Army modernization actions in the areas of doctrine, training, leader development, organization, and materiel (DTLOM) in prioritized order. In the development of the AMM for programming cycle FY94-08, there were approximately 500 modernization candidates for these domains, termed ***solution components***. The solution components formed the *lower level* of the Army Modernization Memorandum's hierarchical structure, of which nearly 400 were materiel candidates. The *materiel candidates* are those that are of concern in the LRAMRP, and hence have the most relevance, to this effort. [Ref. 7]

The AMMs for the FY92-06 and FY94-08 programming cycles were built around the concept of ***capability packages,*** an intermediate or *middle level* of the Army Modernization Memorandum's hierarchical structure, which "... defined base and required capabilities and focused modernization solution alternatives for specific battlefield functions." [Ref. 4] These capability packages were defined within the Army's seven battlefield functional mission areas of maneuver, fire support, air defense, mobility and survivability, intelligence, command and control, and combat service support. These functional areas were defined across the spectrum of combined arms conflict which the Army expects to be engaged. Hence, the capability packages were considered the cornerstones for building Army modernization requirements and priorities. Additionally, they were significantly affected by the level of combat intensity under consideration as well. The solution components for each of the DTLOM domains discussed above were developed and designed to reduce the shortfall capability package requirements. Figures 2 and 3 depict, respectively, capability packages as they relate to the Army Modernization Memorandum's hierarchical structure and a typical capability package hierarchy consisting of intermediate elements and solution components. [Ref. 7]

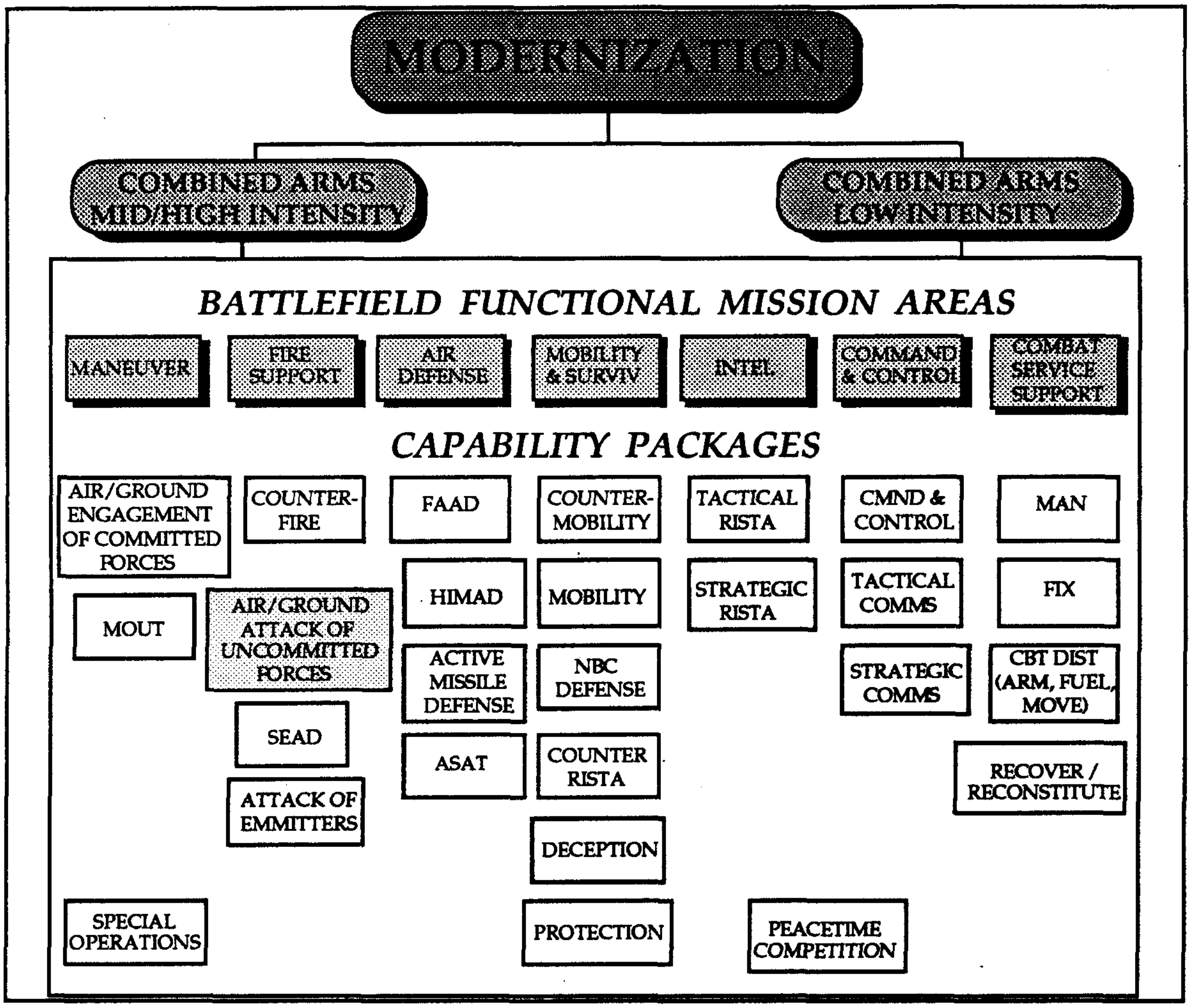

Figure 2. Modernization Schema

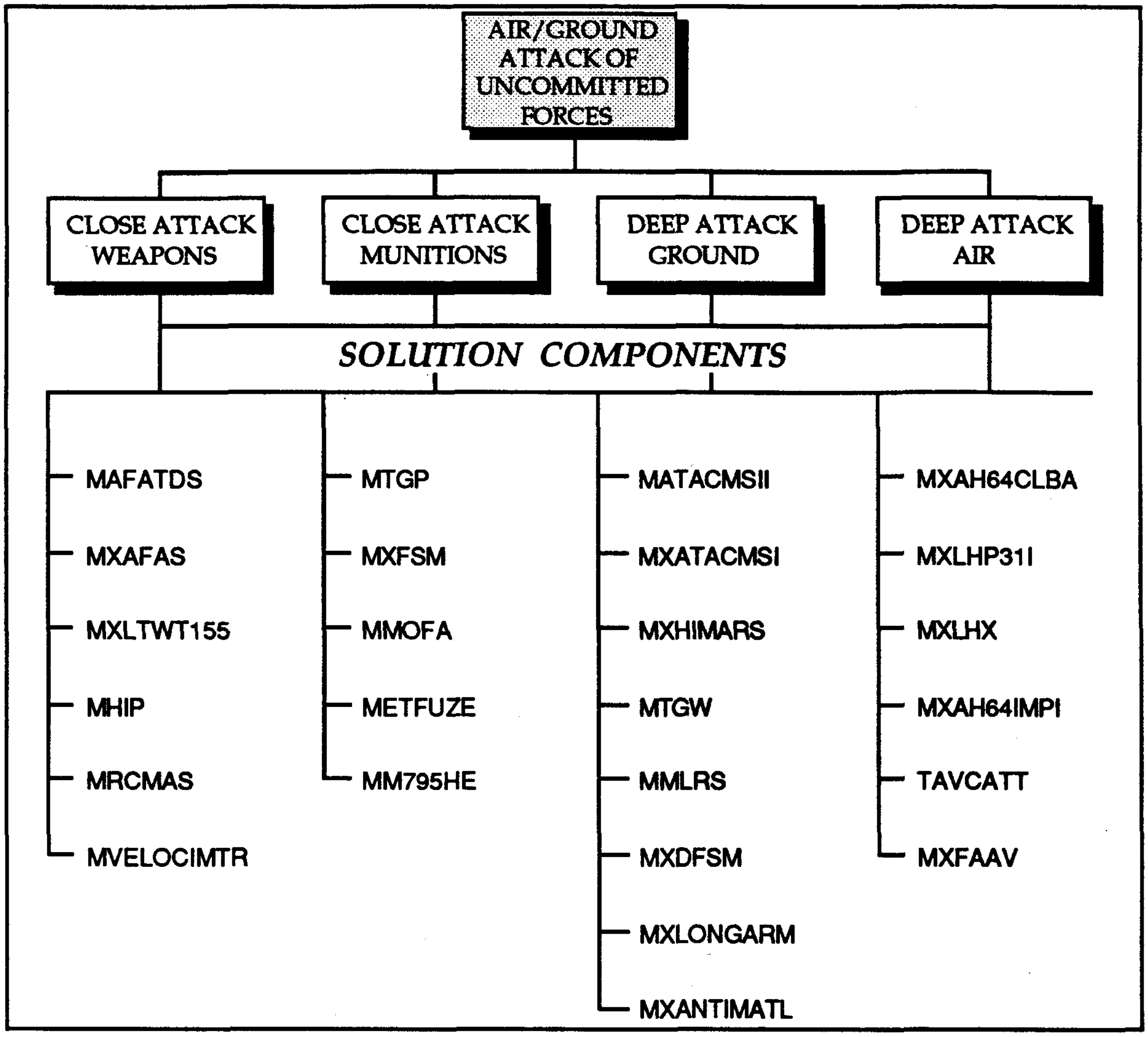

Figure 3. Capability Package Hierarchy

The *upper level* of the AMM hierarchical structure reflected the planning strategy and priorities of the Army's senior leadership vision of the future, modernized force.

An Army Chief of Staff's paper, ***The United States Army: A Strategic Force of the 1990s and Beyond,*** discussed the need for evolving priorities among the following five strategic roles envisioned for the future Army:

- *To provide forward deployed ground forces for deterrence, sustained land combat, and conflict termination in areas of vital interest;*

- *To maintain combat-ready ground forces, heavy, light, and special operations, in CONUS for immediate contingencies worldwide;*

- *To maintain forces in CONUS able to reinforce forward deployed and contingency forces;*

- *To provide support to allied and friendly nations through peacekeeping, security assistance, and Army-to-Army initiatives; and*

- *To participate in disaster relief, emergency assistance, and interdiction of illicit drug traffic.*

These strategic roles were reflected in the five force types of forward presence, contingency, reinforcing, nation development, and unique mission forces that appeared in the *upper level* of the hierarchical structure along with the levels of combat intensity. Figure 4 depicts the upper, middle, and lower levels of the Army modernization hierarchical structure used to determine the priorities in the AMM 94-08. [Ref. 7]

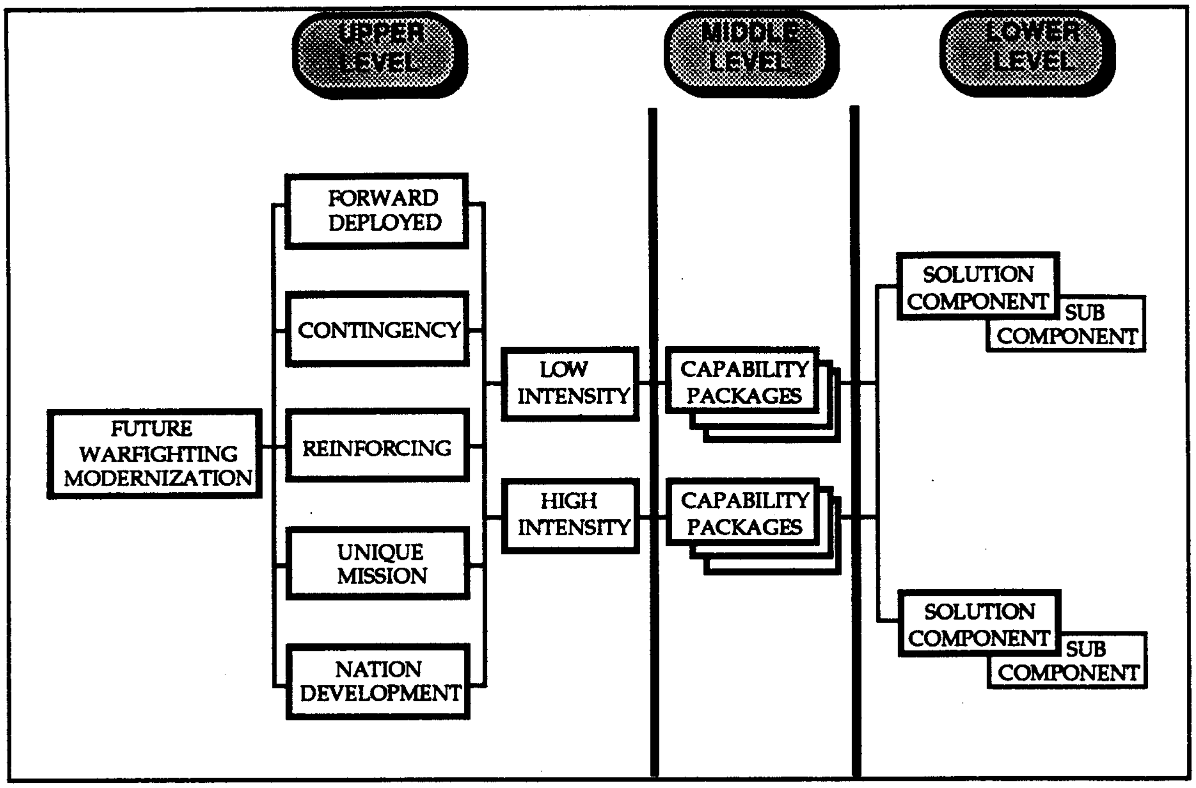

Figure 4. The Army's Modernization Hierarchical Structure

(3) Long Range Army Materiel Requirements Plan (LRAMRP). The Long Range Army Materiel Requirements Plan is the final CBRS product. It develops the financial program for acquiring Army research and development and materiel procurements as it incorporates the projected research, development, and acquisition dollars available for modernization in each of the next fifteen fiscal years as well as the AMM priorities. In conjunction with the development of the AMM, the Army's Program Managers/Program Executive Officers (PMs/PEOs) define, research, and structure programs for consideration to correct the battlefield capability issues and meet modernization needs. Through this process, the PMs/PEOs propose individual program investment strategies that they feel will best meet the Army's need for modernization in a particular area. In the LRAMRP process,

these proposed program investment strategies are known as ***management decision packages (MDEPs)***. Each MDEP may have up to ten sub-elements, called *increments*, associated with it. The first increment of an MDEP is the primary increment and must exist, hence must be funded, prior to any other increment(s). For the LRAMRP FY94-08 programming cycle, approximately 300 MDEP increments were developed from the nearly 400 materiel solution components. Once all the MDEPs were formulated, the priority and relative effectiveness of each MDEP was derived from the AMM priorities in terms of its potential contribution to warfighting effectiveness. This was done using the Analytic Hierarchy Process described in Chapter II. Thereafter, a heuristic capital allocation algorithm was applied to the MDEPs to consider MDEP values against their resource implications. Ultimately, this procedure recommends the set of modernization MDEPs that promises the maximum warfighting value to the Army within the constrained RDA dollars available. Although the LRAMRP recommendations are derived from the relative priorities of the AMM, many final adjustments are required since the LRAMRP recommendations do not consider any other goals or objectives besides RDA costs and the aforementioned priorities. Once the adjustments are made and the recommendations of the AMM and LRAMRP conform, the LRAMRP is finalized and submitted to Headquarters, Department of the Army. [Ref. 8, 9]

D. OBJECTIVE

The specific objective of this thesis effort was to develop a multiple criteria model to replace the heuristic capital allocation algorithm described above. By using the proposed thesis model, TRADOC and the CBRS process will benefit by employing a model that considers multiple modernization goals and objectives. Consequently, the thesis model will significantly aid TRADOC in the design of the LRAMRP and significantly reduce the amount of manual adjustments and time needed to arrive at a final LRAMRP recommendation.

II. METHODOLOGY

A. THE CAPITAL BUDGETING PROBLEM

The problem of selecting a subset of programs, projects, investment packages, etc., from a given set, within a certain framework of budgetary and other resource limitations, is commonly referred to as a *capital budgeting problem*. Due to its widespread applications and importance, the problem is also referred to as the *project selection problem* and the *knapsack problem*. The knapsack problem is characteristic of the type of problem a hiker faces when selecting items, each characterized by size and comfort level it will provide, to go in a knapsack with a given capacity. The trade-off between how much comfort an item might provide to the hiker (analagously, how much warfighting value an MDEP will contribute to the overall Army modernization investment strategy) and how much space it will occupy in the knapsack (how much the MDEP will cost) is the essence of the capital budgeting problem. The objective is to *maximize* the payoff of the projects selected while satisfying the implied resource limitations over the time horizon under consideration. [Ref. 10]

1. Current Heuristic Approach

TRADOC currently applies a *heuristic* capital allocation algorithm to recommend a set of modernization candidates for the capital budgeting problem described in Chapter I. This algorithm was originally devised by Senju and Toyoda [Ref. 11] and later popularized by Woolsey and Swanson [Ref. 12]. This heuristic approach is easily implemented with the aid of a spreadsheet and can be demonstrated with the following example [Ref. 9].

Consider six candidate modernization systems, labeled A, B, ..., F, competing for limited funds across a time horizon of only two time periods. Each system is given a respective *payoff* or warfighting contribution value, expressed as a percent value, with the total of the warfighting contribution values summing to 100. The dollar costs, in millions of dollars, represent the costs of each of the candidate systems, for each of the given time periods. The sample data for this example are shown below in Table 1.

TABLE 1. DATA TO ILLUSTRATE HEURISTIC CAPITAL ALLOCATION ALGORITHM

Candidate System	*Rank*	*Warfighting Value*	*Mdollars Required in 1st Time Period*	*Mdollars Required in 2nd Time Period*
A	1	23	120	125
B	2	22	75	75
C	3	17	180	100
D	4	15	60	50
E	5	14	75	120
F	6	9	140	180

For this simple example, further assume spending has been restricted to $400 million in the first time period and $450 million in the second time period. The objective of the problem is to determine which candidate systems should be pursued given the budgetary guidelines set by higher headquarters. At this point, since the projects are listed in descending order of warfighting value, one might be tempted to take a *greedy* approach to the problem by simply selecting the projects in descending order until the budgetary limitations are reached within one of the two time periods. Using this approach, System A may be selected and represented as a vector with termination coordinates representing the amount of resources to be consumed by the system in the two time periods (i.e., [120, 125]). From this termination point, the second system is selected and the amount of resources it consumes in the two time periods is added using vector addition (i.e., [120, 125] + [75, 75] = [195, 200]). This approach of vector addition continues until the resulting termination point ([400, 450]) exceeds the resource limits. The result of this naive approach, shown graphically in Figure 5, is only three systems selected with a resulting payoff of only 62% of the total warfighting value. [Ref. 9]

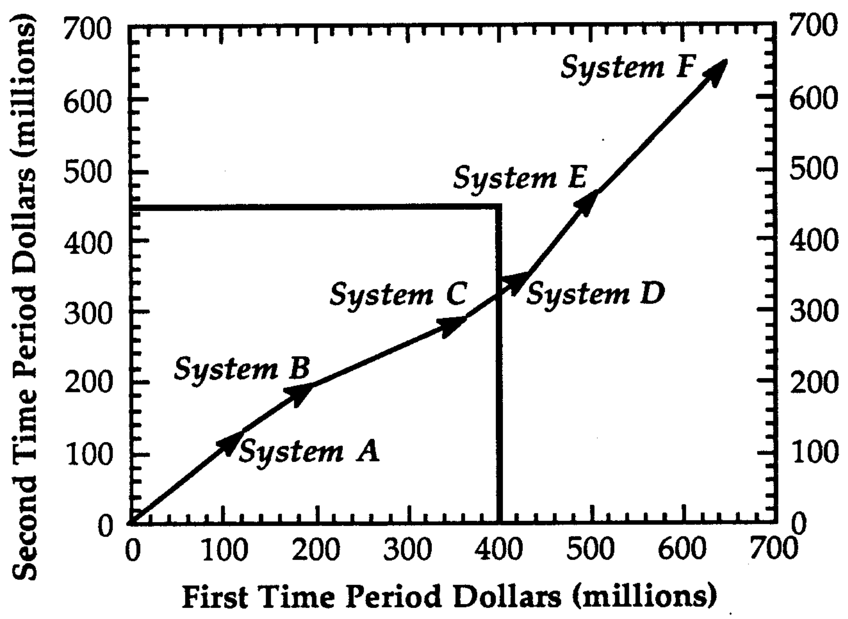

Figure 5. Results of Greedy Approach: 3 projects funded, 62% warfighting value obtained

Table 2 shows the implementation of the heuristic algorithm as described by Woolsey and Swanson [Ref. 12] on the example. The following procedure is applied:

- *For each system, the expected payoff (i.e., warfighting value) and the amount of each resource it will require in each respective time period is entered.*

- *For each resource, the total amount available in each time period is entered under the Limit column and the total amount required is entered under the Requirement column.*

- *The difference between required and limit (R-L) is determined and entered in the shortfall or slack column.*

- *For each system, each resource requirement is multiplied by the appropriate shortfall entry and the resulting product entered under the appropriate column for each system. The resulting products are summed across each resource and entered in the appropriate Cost Factor cell under each system.*

- *The Value/Cost ratio for each system is determined by dividing the Value of each system by the sum in the Cost Factor cell.*

- *The projects are then selected in descending order of value-to-cost ratio. Since larger ratios indicate more effective value in terms of utilized resources, the ordering and selection of systems are based purely on the size of the value-to-cost ratios. The only exception to this is in the selection of a lower ranking system when the selection of a higher ranking system would exceed the resource limitations.*

TABLE 2. DEVELOPMENT OF HEURISTIC VALUE-TO-COST RATIOS

Row	*Category*	*Project A*	*Project B*	*Project C*	*Project D*	*Project E*	*Project F*	*Requirement (R)*	*Limit (L)*	*Shortfall (R-L)*
1	Value	23	22	17	15	14	9			
2	Resource 1 required	120	75	180	60	75	140	650	400	250
3	Resource 2 required	125	75	100	50	120	180	650	450	200
4	Resource 1 × (R-L)	120×250 30,000	75×250 18,750	180×250 45,000	60×250 15,000	75×250 18,750	140×250 35,000			
5	Resource 2 × (R-L)	125×200 25,000	75×200 15,000	100×200 20,000	50×200 10,000	120×200 24,000	180×200 36,000			
6	Cost Factor (10,000s)	5.5000	3.375	6.500	2.500	4.275	7.100			
7	Value/Cost	4.18	6.52	2.62	6.00	3.27	1.27			

The graphical interpretation of the results using this heuristic selection process is shown below in Figure 6.

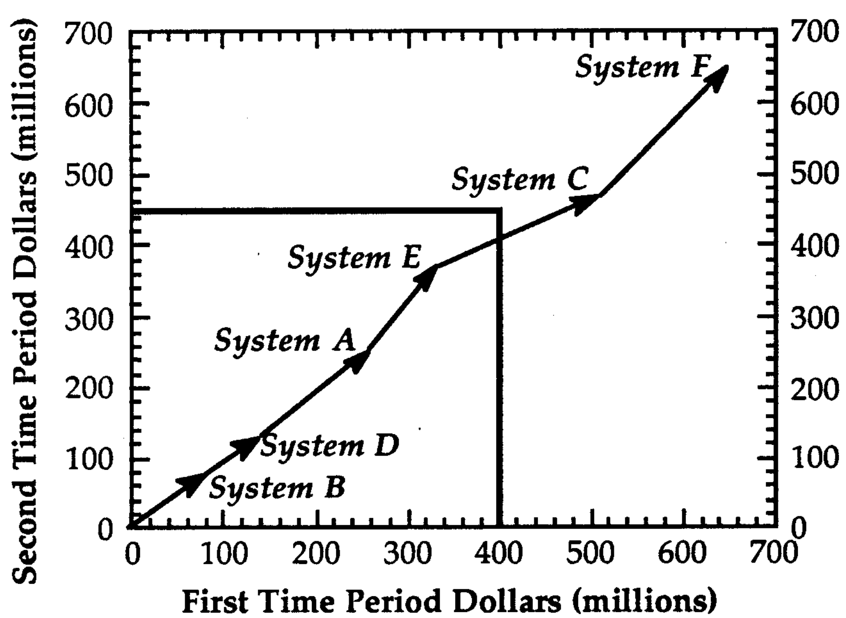

Figure 6. Results of Senju-Toyoda Value-to-Cost Ratios: 4 projects funded, 74% warfighting value obtained

Selecting the systems based on value-to-cost ratios and plotting resource requirements as termination points, then adding subsequent termination points vectorally as in the greedy approach, maximizes the total value of the systems subject to the resource constraint box by selecting as many high ratio systems as possible. With this approach, four systems are selected (A, B, D, and E) as opposed to three in the greedy approach (A, B, and C). Additionally, the heuristic algorithm yields a 74% total payoff as opposed to 62% using the greedy approach, a 12% increase. Although the heuristic algorithm approach provides a better solution for this small problem, it doesn't guarantee a mathematically optimal solution in general. Additionally, the heuristic procedure described can't handle the mixing of different resource costs and constraints which, more importantly, doesn't allow trade-offs for establishing a balanced investment strategy. [Ref. 9]

2. A Linear Zero-One Programming Approach

The simplest capital budgeting problem is formulated using linear integer programming with binary variables. This simple model assumes a single resource constraint. The objective is to choose an optimal subset of projects that maximizes the total value, contribution, or payoff of the investments within the resource budget. The formulation is represented in the following standard form [Ref. 13: p. 5] :

Given:

n = the number of candidate projects ;

c_j = the value or payoff of the *jth* project ;

a_j = the cost of the *jth* project ;

b = the budget allocated to fund the projects

Find x_j to:

$$\textit{Maximize} \sum_{j=1}^{n} c_j x_j$$

subject to:

$$\sum_{j=1}^{n} a_j x_j \leq b \;;$$

$$\textbf{where:}\; x_j = \begin{cases} 1 & \text{if the } jth \text{ project is selected} \\ 0 & \text{if the } jth \text{ project is not selected} \end{cases}$$

This approach has limited real world applications because of the single resource and also the single objective. Realistically, decision makers involved in this type of problem have several objectives in mind, particularly those involved in developing a balanced Army modernization investment strategy over a multiple year time horizon. Hence, the linear zero-one programming approach, although mathematically superior to the heuristic algorithm, does not provide an adequate solution to the competing objectives of the Army planning and programming problem. [Ref. 10]

3. Multiple-Objective Linear Programming

Several approaches have been proposed to the multiple-objective linear programming problem. The following three approaches form the basis for most of the proposed multiple-objective techniques [Ref. 14]:

- *Weighting or utility methods*
- *Ranking or prioritizing methods*
- *Efficient solution (or generating) method*

The weighting or utility methods simply transform a multiple-objective model into a single-objective model by expressing all of the objectives in terms of a single numerical measure (e.g., dollars or "utiles"). The obvious disadvantage to this technique is in developing credible weights. [Ref. 14]

The ranking or prioritizing approach simply requires the decision maker to rank the objectives in terms of their perceived importance. Although this approach avoids having to determine credible weights for each objective, the disadvantage is that there is no apparent measure to convincingly associate the solution results to the consistency of the rankings. [Ref. 14]

The third approach attempts to generate the total set of efficient solutions or nondominated solutions, also called the Pareto optimal solutions. Once this set of efficient solutions is developed, it is presented to the decision maker for him or her to rationally determine the most preferred. Although this approach avoids the problems associated with the weighting and ranking methods, it is often impractical because the complete set of efficient solutions can be too large to enumerate and present to the decision maker. [Ref. 14]

A fourth approach to the multiple-objective problem, called the *goal programming model*, was developed by Charnes and Cooper [Ref. 15] and popularized by Ignizio. The model development process for this flexible and efficient approach is straightforward and simple to implement. In fact, variations of the goal programming approach have been extensively implemented in real-world problems since the early 1950s. Above all, the goal programming model and its assumptions are realistic and consistent with typical multiple-objective problems. Hence, this approach was selected as a basis for developing the optimization model that is the focus of this thesis. [Ref. 14]

B. THE WEIGHTED LINEAR GOAL PROGRAMMING MODEL

The weighted linear goal programming model is a specific form of the goal programming methodology. Before proceeding further, it is necessary to establish a clear understanding of the unique terms associated with a goal programming model that differ from a conventional mathematical programming formulation. The following definitions are provided [Ref. 14] :

Objective: An objective is a general statement that reflects the desires of the decision maker (e.g., "maximize profit," "minimize cost," etc.).

Aspiration Level: An aspiration level is a desired or acceptable level of achievement, specified by the decision maker, associated with the accomplishment of an objective.

Goal: A goal is an objective that is stated in conjunction with an aspiration level. Hence, all of the nonabsolute constraints of the linear goal programming model are goals, stated with equality signs, which may or may not be achieved. These goals must be scaled and/or weighted appropriately to ensure they are commensurate. Goals are also referred to as *elastic constraints*.

Goal Deviation: Any over or under achievement of a stated goal is termed a goal deviation. For each goal, it is the difference between what is accomplished and what is aspired. Realistically, most goals will have some level of under (negative) or over (positive) achievement (deviation) associated with them. Hence, the desire for a goal programming formulation is to minimize the goal deviations.

Achievement Function: The goal programming achievement function indicates the degree of achievement of the associated goals. For the weighted linear goal programming model, it contains all of the weighted and scaled deviations from the model goals hence, it is the quantity to be minimized.

The weighted linear goal programming approach is a flexible formulation to the Army's capital budgeting problem. This flexibility allows tradeoffs among the goals by aggregating all of the weighted, and scaled if necessary, deviations into a single achievement function [Ref. 2: p. 88]. The weights associated with the negative and/or positive goal deviations are essentially the penalties for under and/or over achieving the stated aspiration levels. Fundamentally, this approach requires the decision maker to accurately establish and assess these penalties. For the purposes of this study, the senior Army leadership involved in creating a modernization investment strategy are capable of developing valid weighting functions for the deviation variables. In fact, the power of the weighted linear goal programming formulation lies in the ability of the decision maker to rapidly change these weights (penalties) in order to compare varying investment strategies and the resulting effects on the funding measures of balance and turbulence. It takes the following form [Ref. 14: p. 483] :

Given:

η_s = the negative deviation from the aspiration level of goal s ;

ρ_s = the positive deviation from the aspiration level of goal s ;

u_s = weighting factor for the negative deviation of goal s ;

w_s = weighting factor for the positive deviation of goal s ;

z_s^0 = aspiration level for objective s ;

$z_s(\cdot)$ = linear function representing goal s

$$\textit{Minimize} \sum_{s=1}^{S} \left(u_s \eta_s + w_s \rho_s \right)$$

subject to:

$$z_s(x) + \eta_s - \rho_s = z_s^0, \; s = 1, \ldots, S$$

$$Ax \leq b \;\; ;$$

$$x, \eta, \rho \geq \bar{0}$$

where:

$Ax \leq b$ represents the set of all absolute constraints (if any)

Of equal importance is the fact that a relatively large problem formulated with the weighted linear goal programming approach can be solved readily using commercially available linear programming software that is reasonably priced. Additionally, since the weighting of goals in the Army's capital budgeting problem will certainly be subjective in nature, the ability of a model to allow tradeoffs between investment goals and objectives is that much more critical. Hence, the weighted linear goal programming model was judged to best suit the Army's decision making environment in developing modernization investment strategies. [Ref. 2: pp. 91-92]

C. DETERMINATION OF WARFIGHTING VALUE

1. The Analytic Hierarchy Process (AHP)

A primary goal of the Army's investment strategy is to maximize its potential warfighting capability. Each candidate MDEP increment is given a benefit coefficient, called a warfighting value, assessed by Saaty's Analytic Hierarchy Process [Ref. 16]. The process is initially applied to the solution components derived in the development of the AMM and then translated to the MDEP increments developed for the LRAMRP. The ***Analytic Hierarchy Process (AHP)*** is "a systems analysis approach that allows large complex problems to be decomposed into elements, relationships to be assessed among elements, and, ultimately, synthesis of the assessed relationships into system impacts." [Ref. 9] For CBRS cycle 94-08, the AHP was implemented to develop a warfighting value for each solution component. The process involved the following four steps:

Step 1: A modernization hierarchical structure of interrelated decision elements was developed. This resulted in the upper, middle, and lower level modernization hierarchy shown in Figure 4 of Chapter I.

Step 2: Subjective pairwise comparison data were collected for each level of the hierarchy using structured surveys and evaluation boards. The data were subsequently reformatted into pairwise comparison matrices for analysis in Step 3. Selected general officers provided input values for the five force types and two levels of combat intensity in the upper level of the modernization hierarchy. For the middle level of the hierarchy, selected colonels and a senior civilian valued each capability package for each combat intensity level. Finally, three evaluation panels consisting of military and civilian action officers valued the solution components in each capability package.

Step 3: Saaty's eigenvalue method [Ref. 17] was used to provide the best estimates of the relative weights of the decision elements at each level of the hierarchy.

Step 4: The relative priority weights of the upper, middle, and lower levels were then synthesized into composite weights using Saaty's principles of hierarchical composition [Ref. 16, 17]. This series of matrix and vector products, corresponding to the hierarchical structure, resulted in the estimated warfighting values for each of the lower level solution components. These values were normalized to the sum total of 1000.0 rather than 1.000 for ease of expression.

A detailed explanation of the decision support provided by TRAC-OAC for the CBRS FY94-08 cycle, specifically in the use of the AHP to derive the solution component priority weights for the AMM, can be found in Reference 7.

As previously mentioned, priority weights for solution components are translated into warfighting values for each MDEP increment in the development of the LRAMRP. The entire process of determining these warfighting values is a critical step in developing the required input to the optimization model described in Chapter III. Although Saaty's AHP is not universally accepted without criticism [Ref. 17], it has been accepted by senior Army leadership as an appropriate decision support aid for translating subjective evaluations into realistic, quantifiable values that characterize project contribution to overall warfighting capability.

D. THE GENERAL ALGEBRAIC MODELING SYSTEM (GAMS)

A modeling language approach was selected over other modeling options, such as matrix generation and standard conversational solvers, to implement the linear goal programming formulation described above. Most modeling languages allow for fast prototyping as they provide direct translation and allow models to be described very efficiently. Additionally, modeling languages are easy to verify, modify, and document as opposed to matrix generation, which is very slow to develop, or a conversational solver which is instance specific and doesn't capture the flexibility and generality of a modeling language. Although several modeling languages exist, by far the most versatile and most developed is the General Algebraic Modeling System (GAMS). With ten years of testing and hundreds of hours of person-years in student testing, GAMS balances realism with tractability. It provides a high-level language that uses algebraic modeling for compact representation of large, complex models. This is done through the use of unambiguous statements of algebraic relationships that permit model descriptions independent of solution algorithms. Specifically, GAMS accommodates linear, nonlinear, and mixed integer optimizations while incorporating relational data base theory and mathematical principles. Hence, it allows rapid changes in model specifications as the model is expressed independent of the data it uses. Above all, the portability, self-documenting, and post-optimization report writing features of GAMS were essential to building a flexible, responsive multi-objective optimization model to meet the user's needs. [Ref. 1]

III. MODEL DEVELOPMENT

The model for TRADOC's multiple-objective budgeting problem was developed using the goal programming approach discussed in Chapter II. The author established and maintained a close working relationship with the user at Fort Leavenworth to ensure accurate representation of the many competing, and often conflicting, goals and constraints that characterize the intricate framework of the Army's budgeting environment.

The modernization goals with their respective aspiration levels, the absolute constraints, and the logical funding relationships, called logical constraints, that could likely exist between competing MDEP increments, were developed initially. The model variables were then developed along with the parameters and scalars necessary as inputs to the goals and constraints. Finally, the achievement function was developed along with the weight and scaling factors for each modernization goal. The model was then implemented in GAMS.

Throughout model development, all input sets, parameters, tables, scalars, and variables were declared and assigned using the GAMS structure. The input equations (i.e., goals and constraints) were declared and defined using the GAMS structure as well. Prior to discussing the formulation of the modernization goals and system constraints, it is necessary to define the sets, variables, and parameters that make up their algebraic representation.

Table 3 summarizes the sets that represent the given domains over which the variables, equations, and input data for the model are defined.

TABLE 3. SET DECLARATION

SET	DEFINITION
i	management decision package (MDEP)
j	MDEP increment level
k	TRADOC mission area that is the proponent for the MDEP increment
t	fiscal years in the time horizon under consideration

Set *i* represents each of the MDEPs under consideration for funding. Each MDEP may be broken into several components, called *increments*. For the purposes of this thesis, each MDEP was considered to have at most ten increments, indicated by set *j*, assigned to it. In order for an MDEP to exist and be considered for funding, it must have an "01" increment. Hence, the set *i* represents the MDEP titles associated with the "01" increments. However, an MDEP is not required to have any additional increments. Likewise, if additional increments exist, they are not required to appear sequentially and may occur in any combination of the remaining nine levels.

Set *k* represents the eleven TRADOC mission areas. In 1979, TRADOC instituted a mission area approach, as part of the CBRS, to identify battlefield capability issues and generate modernization initiatives. With this approach, battlefield responsibilities are currently partitioned into the following eleven subordinate mission areas:

Close Combat Heavy [CCH]
Close Combat Light [CCL]
Aviation [AVN]
Air Defense [AD]
Communications [COM]
Fire Support [FS]
Engineering and Mine Warfare [EMW]
Combat Service Support [CSS]
Nuclear, Biological, and Chemical [NBC]
Intelligence and Electronic Warfare [IEW]
Command and Control [C2]

As a result, these mission area proponents (i.e., assigned TRADOC schools and support centers) are the "owners" of the associated MDEPs found in the LRAMRP. [Ref. 18]

Set t represents the fiscal years in the time horizon under consideration. For the model runs conducted as part of this research, set t is composed of the fifteen fiscal years of the LRAMRP programming cycle, but this and all other inputs can be easily modified if desired.

A. DECISION VARIABLES

Positive continuous and binary decision variables are used as the activity levels to be determined by the model. Unlike the typical class of capital budgeting problems where there is only one discrete binary decision variable to determine whether or not a project is funded, the use of additional positive continuous variables is well suited for TRADOC's LRAMRP budgeting problem. The use of continuous and binary decision variables allows tradeoffs between the competing, and often conflicting, goals and constraints imposed upon the model.

A positive continuous variable, X_{ijt}, ranging from 0 to 1 represents the fraction of aspired level of funding to MDEP i, increment j, in time period t. The binary variable, Z_{ij}, is used primarily in expressing the complex funding relationships (called logical constraints) between several of the MDEP increments. Binary variables are also used in the formulation of the incremental constraints discussed in Section D of this chapter. Table 4 summarizes the *decision variables* used in developing the model.

TABLE 4. DECISION VARIABLES

DECISION VARIABLE	DEFINITION	RANGE
X_{ijt}	fraction of aspired level of funding for the *jth* increment of MDEP *i* in fiscal year *t*	0 to 1
Z_{ij}	$\left\{\begin{array}{l} 1\text{ ; if the } jth \text{ increment of MDEP } i \text{ is funded} \\ 0\text{ ; if the } jth \text{ increment of MDEP } i \text{ is not funded} \end{array}\right\}$	0 or 1

Table 5 summarizes the positive continuous *deviation variables* used to represent the positive and/or negative deviations from the aspiration level of each modernization goal. Hence, these variables are used to determine the effects on the "return on investment" with changing priorities.

TABLE 5. DEVIATION VARIABLES

POSITIVE VARIABLE	DEFINITION	RANGE
$NWARVAL_t$	negative deviation from aspired warfighting value in fiscal year *t*	0 to +∞
$NBAL1_{kt}$	negative deviation from desired level of funding for TRADOC mission area *k* in fiscal year *t*	0 to +∞
$NBAL2_{kt}$	negative deviation from minimum level of funding for TRADOC mission area *k* in fiscal year *t*	0 to +∞
$PBAL1_{kt}$	positive deviation from desired level of funding for TRADOC mission area *k* in fiscal year *t*	0 to +∞
$PBAL2_{kt}$	positive deviation from maximum level of funding for TRADOC mission area *k* in fiscal year *t*	0 to +∞
$NTURB_{ijt}$	negative deviation from stable funding of the *jth* increment of MDEP *i* in fiscal year *t*	0 to +∞

B. INPUT DATA

Several parameters and scalars are declared to represent the various funding levels and warfighting values required as model inputs. The AHP warfighting value for each MDEP increment is represented by $WARVAL_{ij}$.

Funding data includes TRADOC's yearly warfighting budget, the aspired level of funding for each MDEP increment, and the estimated operation and support costs for each MDEP increment across the time horizon. The minimum, desired, and maximum funding levels for each of the TRADOC mission areas are expressed as a percent of the yearly warfighting budget. The minimum funding level for each of the ten possible MDEP increments is established as well. Table 6 summarizes the input parameters.

Specific funding and warfighting scalars and parameters are derived from the input data. The total amount of operation and support costs is determined as the sum of all the MDEP increment operation and support costs. The warfighting value of each MDEP increment is assumed to accumulate linearly across the project's life cycle according to dollars sought. Hence, an MDEP's total warfighting value cannot be achieved until the last fiscal year in the project's life cycle in which funds are aspired. This is a realistic approach since each MDEP increment contributes more to the Army's warfighting capability the further along it is in the development process. Finally, the maximum achievable warfighting value in a given fiscal year is determined as the sum of the accumulated warfighting values for all MDEP increments in that year. Table 7 summarizes the derived data described above.

TABLE 6. INPUT DATA

INPUT PARAMETER	DEFINITION
$BUDGET_t$	TRADOC warfighting budget allocation (thousands of dollars) for fiscal year *t*
$ASPIRE_{ijt}$	aspired level of funding (thousands of dollars) for the *jth* increment of MDEP *i* in fiscal year *t*
$TOTASPIRE_{ij}$	total aspired funding (thousands of dollars) for the *jth* increment of MDEP *i* across the time horizon
$MINLEVEL_j$	minimum increment funding level for MDEP increment *j* across the time horizon if it is funded at all
$OSCOST_{ij}$	operation and support costs (thousands of dollars) for the *jth* increment of MDEP *i*
$RAMP_{ij}$	ramp-up funding factor for the *jth* increment of MDEP *i*; specified as a fraction of the previous year's funding level aspired for current year
$MANDATE_{ij}$	Congressionally mandated increment *j* of MDEP *i* ; [equals 1 if the *jth* increment of MDEP *i* is mandated; equals 0 otherwise]
$SHAREDATA_{k,\ MINIMUM}$	*minimum* level of funding (% of annual budget) for TRADOC mission area *k*
$SHAREDATA_{k,\ DESIRED}$	*desired* level of funding (% of annual budget) for TRADOC mission area *k*
$SHAREDATA_{k,\ MAXIMUM}$	*maximum* level of funding (% of annual budget) for TRADOC mission area *k*
MAXOSCOST	maximum value for operation and support costs (thousands of dollars) over the time horizon
$WARVAL_{ij}$	composite priority weight factor (AHP warfighting value) for the *jth* increment of MDEP *i*

TABLE 7. DERIVED DATA

DERIVED SCALAR/PARAMETER	DEFINITION	DERIVATION
TOTOSCOST	total operation and support costs (thousands of dollars) for all MDEP increments across the time horizon	$\sum_{ij} OSCOST_{ij}$
$MAXWARVAL_t$	maximum warfighting value in fiscal year *t*; equals the sum of the proportional composite priority weight factors in fiscal year *t*	$\sum_i \sum_j \frac{WARVAL_{ij}}{TOTASPIRE_{ij}} \times \sum_{t' \le t} ASPIRE_{ijt'}$

C. MODERNIZATION GOALS

The basis for the model formulation is the establishment of three modernization goals that shape the Army's modernization investment strategy. These goals reflect the policy and guidelines set forth by TRADOC and Headquarters, Department of the Army, for investing RDA funds to improve the Army's warfighting capability. The resulting equilibrium from maximizing warfighting value, maintaining mission area balance, and minimizing funding turbulence ensures a versatile, lethal, deployable, and expansible force capable of fulfilling the nation's future needs.

1. Formulation

a. Achieve Desired Warfighting Value

The major goal of the United States Army modernization strategy is to improve its warfighting capability. Hence, the most important goal in the model, and the one that carries the most weight, is to fund the MDEP increments that yield the most warfighting value. The theoretical maximum warfighting value for each fiscal year is determined as the sum of the cumulative proportional warfighting values described in Table 7. This is the *desired* warfighting value for each fiscal year. Since the desired yearly warfighting value is a theoretical maximum, there can only be a negative deviation from it. Equation 3-1 gives the algebraic representation of the warfighting goal using the variables and parameters in Tables 4-7.

$$\sum_i \sum_j \frac{WARVAL_{ij}}{TOTASPIRE_{ij}} \sum_{t' \le t} ASPIRE_{ijt'} X_{ijt'} + NWARVAL_t = MAXWARVAL_t \; ; \; \forall t \qquad (3\text{-}1)$$

b. Maintain Mission Area Balance

The second most important goal in developing an investment strategy for a modernized Army is to ensure *balanced* funding across all areas that make up the force. This ensures that all areas of the force achieve their potential warfighting capability. TRADOC establishes desired, minimum, and maximum funding levels, expressed as percentages of the budget, for each of the TRADOC mission areas. These funding levels are designed to ensure an equitable distribution of investment funds across the mission area proponents. Hence, in order to achieve a balanced funding strategy, the fraction of dollars funded for a given mission area in a given fiscal year must be as close as possible to the desired level of funding for that mission area in that fiscal year. Since the aspiration level for this goal is a *desired* funding level for each TRADOC mission area, and not a minimum or maximum funding level, there can be a positive and negative deviation associated with it. This results in the *doubly elastic* formulation represented in Equation 3-2, where each type of deviation is represented by two deviation variables.

$$\sum_{i \in k} \sum_{j \in k} X_{ijt} \frac{ASPIRE_{ijt}}{BUDGET_t} + NBAL1_{kt} + NBAL2_{kt} - PBAL1_{kt} - PBAL2_{kt} = SHAREDATA_{k,\ DESIRED} \quad ; \forall\, k, t \qquad (3\text{-}2)$$

The bounds on the first deviations are determined directly from the minimum and maximum mission area funding levels specified by TRADOC. The desired, minimum, and maximum funding levels for each TRADOC mission area, given by the parameters $SHAREDATA_{k,DESIRED}$, $SHAREDATA_{k,\ MINIMUM}$, and $SHAREDATA_{k,\ MAXIMUM}$ respectively, are used to specify these bounds under the doubly elastic formulation discussed above. The constraints for the minimum and maximum mission area funding levels are shown in Equations 3-3 and 3-4 respectively.

$$NBAL1_{kt} \leq SHAREDATA_{k,\ DESIRED} - SHAREDATA_{k,\ MINIMUM} \qquad (3\text{-}3)$$

$$PBAL1_{kt} \leq SHAREDATA_{k,\ MAXIMUM} - SHAREDATA_{k,\ DESIRED} \qquad (3\text{-}4)$$

The concept of double elasticity can best be explained through the use of Figure 6. In goal programming, also called elastic modeling, the aspiration level of a goal, identified on the right hand side of the equality sign, is either achieved or not achieved. A negative deviation from the aspiration level indicates under-achievement of the goal and a positive deviation indicates over-achievement. The under- or over- achievement of a goal's aspiration level carries with it a certain weight or penalty. In a doubly elastic goal, the first amount of any violation has a smaller penalty associated with it than a second amount of violation as shown in Figure 7.

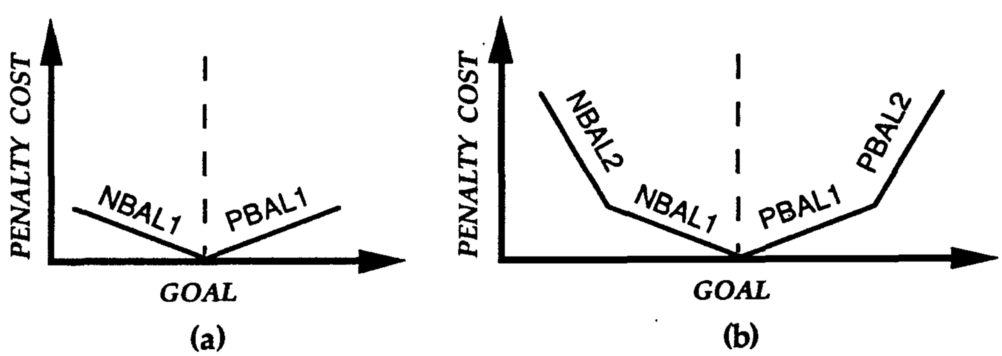

Figure 7. (a) Single Elasticity; (b) Double Elasticity

For the mission area balance goal, the upper bound on the first negative deviation variable, labeled *NBAL1*, is given by the difference between the desired and minimum funding levels for each of the TRADOC mission areas. The upper bound on the first positive deviation variable, labeled *PBAL1*, is the difference between the maximum and desired funding levels for each TRADOC mission area. These bounds are formulated as system constraints. Any negative or positive deviations from these bounds, labeled *NBAL2* and *PBAL2* respectively, have a much higher penalty than any initial violations from the desired funding level. Hence, representing the mission area balance goal as doubly elastic preserves the model's flexibility in allowing *intra*-goal tradeoffs. The decision maker then has the ability to observe the impacts on funding strategy by varying the weights on the deviation variables based on the budgeting environment.

c. *Minimize Funding Turbulence*

The third goal in developing a balanced modernization investment strategy that maximizes warfighting capability is to ensure a continuous funding profile (i.e., non-turbulent) across the time horizon. The life-cycle for several of the MDEP increments obligates funding for up to fifteen years. Large, sudden spikes in the funding profile for a particular MDEP increment are unacceptable and cost-ineffective for long-term Army investments. This requires efficient management of the Army's RDA investments. Hence, to minimize funding turbulence, the fraction of aspired level of funding for the *jth* increment of MDEP i in fiscal year t must be at least 90% as high as the previous year. This "90%" is actually a controllable input parameter called $RAMP_{ij}$. The algebraic representation of the turbulence goal is given below in Equation 3-5.

$$X_{ijt} \geq RAMP_{ij} X_{ij\,t-1} - NTURB_{ijt} \ ; \ \forall\, i, j, t \qquad (3\text{-}5)$$

2. Weighting the Goals

Each of the model goals must be assigned an associated weight based on its perceived relative importance to the Army's modernization effort [Ref. 14]. These weights are then discounted across the time horizon to account for the changing level of importance of achieving the modernization goals in different time periods. Hence, it is more critical to achieve the stated aspiration levels in the early budget years than later in the time horizon during the planning years. The goals were discounted by a factor of 0.995^{t-1}. This very small amount of discounting has the effect of giving a slightly higher priority for meeting goals in earlier years over later years. However, the discounting method can be varied by the model user. Once the goal weights are discounted, they are used as the basis for weighting the positive and/or negative deviation variables associated with each goal. These scalar quantities represent the penalties assigned for not achieving the goal's aspiration level in a given fiscal year.

3. Scaling the Goals

After the model goals are assigned weights based on their relative importance to improving the Army's mission effectiveness, these weights must be adjusted to compensate for the different units of measure in which the goals are expressed. In the weighted linear goal programming formulation, the objective is to minimize the sum of all the goal deviations in the achievement function. Hence, it is necessary to scale the weighted deviations to ensure summation of quantities with like units. This scaling procedure makes the goals commensurable. [Ref. 14]

The three model goals, discussed in detail in subparagraph 1 above, are initially expressed using scalar quantities that are already somewhat commensurable. The goal quantities have no specific dimension (e.g., dollars, hours, etc.) rather, they measure warfighting value, ranging from 0 to 1000, and fractional funding levels, ranging from 0 to 1. A scaling factor is applied to only one of the goals in order to standardize the the magnitude of the goal deviation variables. The weight of the negative deviation from the funding turbulence goal is divided by a scalar representing the number of times funding was aspired in consecutive fiscal years, for all MDEP increments across the time horizon. The weights and scaling factors used in the development of the model goals are summarized in Table 8.

TABLE 8. GOAL WEIGHTS AND SCALING FACTORS

WEIGHTS/SCALING FACTORS	DEFINITION
$WT1$	priority weight of warfighting goal
$WT2$	priority weight of mission area balance goal
$WT3$	priority weight of turbulence goal
$WEIGHT1_t$	discounted weight of warfighting goal in fiscal year t
$WEIGHT2_t$	discounted weight of mission area balance goal in fiscal year t
$WEIGHT3_t$	elastic penalties for mission area balance goal in fiscal year t
$WEIGHT4_t$	discounted weight of turbulence goal in fiscal year t

Although model goals can often be made commensurable by applying relatively simple scaling factors, like the one described above, other scaling methods have been proposed to ensure absolute measures in the deviation variables. Balzer [Ref. 2: pp. 92-96] discusses the use of an application of the Euclidean norm to the goal equation coefficients. This robust scaling method appears widely accepted and well-suited for the weighted linear goal programming formulation, but was not necessary in developing this model.

D. SYSTEM CONSTRAINTS

The system constraints of the model represent the set of absolute conditions that must be adhered to while trying to achieve the modernization goals. Hence, there are no deviation variables associated with them. As with the modernization goals, these constraints reflect the framework set forth by TRADOC and Department of the Army within which the Army's investment strategy must adhere.

1. Formulation

a. Fund Congressionally Mandated Projects

Congress often requires, through appropriating or authorizing legislation, that certain Army projects must be fully funded. [Ref. 2: p. 127]. In the input database to the model, Congressionally mandated MDEP increments are represented by the input parameter $MANDATE_{ij} = 1$. The other projects have $MANDATE_{ij} = 0$. The constraint enforcing this consideration is depicted below in Equation 3-6.

$$X_{ijt} \geq MANDATE_{ij} \;\; ; \;\; \forall\, i, j, t \qquad (3\text{-}6)$$

b. Adhere to Budgetary Restrictions

The amount of investment funds apportioned for each fiscal year is indicated by the parameter $BUDGET_t$. The Army must keep its modernization investments within these budgetary limits. The algebraic representation of this constraint is shown in Equation 3-7. The parameter $BUDGET_t$ is expressed on the left side of the inequality to keep the coefficients of the decision variables within a reasonable magnitude. This scaling technique enhances the performance of the GAMS solver, allowing for timely solutions to the model.

$$\sum_i \sum_j X_{ijt} \frac{ASPIRE_{ijt}}{BUDGET_t} \leq 1 \; ; \; \forall t \tag{3-7}$$

c. *Adhere to Maximum Operation and Support Costs*

Each MDEP increment has various operation and support costs associated with it. These costs are determined as the sum of the following three cost categories [Ref. 19] :

Category 3: Associated total military construction costs.

Category 4: One time initial, fielding costs (e.g., initial spares, first destination transportation costs, new equipment training costs, etc.).

Category 5: Recurring sustainment costs.

The sensitivity of the Army's competitive budgeting environment often precludes the availability of these cost components for input into the model. Hence, the operation and support cost for a given MDEP increment is assumed to be 50% of the total aspired funding in those cases where the three cost category values were given as zero. Resource limitations dictate that the sum of the operation and support costs for all funded MDEP increments, across all of the years in the time horizon, must not exceed a maximum value determined by the decision maker. The algebraic representation of this constraint is shown in Equation 3-8. As with the budget constraint, the large quantities represented on both sides of the inequality sign are scaled by the parameter *TOTOSCOST*, indicating the total operation and support costs for all MDEP increments in the database. Again, this scaling technique reduces the magnitude of the decision variable coefficients, making them more manageable for the GAMS solver.

$$\frac{\sum_i \sum_j OSCOST_{ij} \left(\sum_t X_{ijt} \frac{ASPIRE_{ijt}}{TOTASPIRE_{ij}} \right)}{TOTOSCOST} \leq \frac{MAXOSCOST}{TOTOSCOST} \qquad (3\text{-}8)$$

d. Fund MDEPs Incrementally

The incremental funding constraints mandate that for any funded MDEP, the "01" increment must be funded before any other increments can be considered. This constraint is represented algebraically, using the binary decision variables, in Equation 3-9.

$$Z_{i,"01"} \geq Z_{ij} \; ; \; \forall \, i, j \qquad (3\text{-}9)$$

e. Adhere to Minimum Incremental Funding Levels

The second set of constraints involving increments governs their minimum funding levels. If MDEP increment *ij* is funded at all, then it must receive at least a certain percentage of the total funding it aspires over the time horizon of the model. This percentage, $MINLEVEL_j$, is an input parameter. It is usually set higher for follow-on increments (e.g., 80%) than it is for the initial increment (e.g., 60%). This constraint is represented in Equation 3-10.

$$\sum_{t} X_{ijt} \frac{ASPIRE_{ijt}}{TOTASPIRE_{ij}} \geq MINLEVEL_{j} Z_{ij} \; ; \; \forall \; i, j \qquad (3\text{-}10)$$

f. Link Discrete and Continuous Decision Variables

The final system constraint is not one governed by Army policy or guidelines for investment strategy. Rather, it is a required logical relationship that provides a *linkage* between the binary variables and continuous variables. This constraint has the form known as a ***variable upper bound***. It prevents any expenditure with the continuous variable X_{ijt} whenever the binary variable Z_{ij} is turned off. This linkage constraint is represented in Equation 3-11 below.

$$X_{ijt} \leq Z_{ij} \; ; \; \forall \; i, j, t \qquad (3\text{-}11)$$

E. LOGICAL CONSTRAINTS

The third set of algebraic relationships developed for the model, in addition to the goals and system constraints, is the set of constraints that represent the funding relationships that may exist between competing MDEP increments. This set of conditional relationships contains logical expressions, defined as the set of *logical constraints,* that mathematically represent specific funding conditions. The nine different types of logical constraints formulated for the model will be discussed in the following general categories: *mutually exclusive relationships, complementary relationships,* and *subordinate relationships.* These logical relationships are represented mathematically with the use of binary decision variables and relational operators. The terms MDEP, MDEP increment, and project are used interchangeably in the following formulations for ease of understanding.

1. Formulation

a. *Mutually Exclusive Projects*

Mutually exclusive projects are those MDEP increments that cannot be funded simultaneously. In the case of pairwise mutually exclusive MDEPs, MDEP i or i' may be funded, but not both. Of course, the option of funding neither i nor i' is acceptable. Moreover, the concept of mutually exclusive funding can be extended to several MDEP increments as well as subsets of MDEP increments. The following notation is provided for identifying mutually exclusive sets:

I_1: *the set of all pairwise mutually exclusive MDEP increments ;*

I_2: *the set of all mutually exclusive MDEP increments ;*

I_3: *the set of all mutually exclusive MDEP increment subsets*

Equations 3-12 through 3-14 depict the three types of mutually exclusive funding relationships formulated for this model.

$$Z_{ij} + Z_{i'j} \leq 1 \; ; \; \forall \, (i, i') \in I_1, j, t \qquad (3\text{-}12)$$

don't fund pairwise mutually exclusive MDEPs
*[fund MDEP **i** or MDEP **i'** or neither, but not both]*

$$Z_{ij} + Z_{i'j} + Z_{i''j} \leq 1 \ ; \ \forall \ (i, i', i'') \in I_2, j, t \qquad (3\text{-}13)$$

don't fund mutually exclusive MDEPs
[among MDEPs ***i, i', and i'', can fund at most one of*** *them, or none at all]*

$$Z_{ij} = Z_{i'j} = Z_{i''j} \ ; \ Z_{ij} + Z_{i'''j} \leq 1 \ ; \ \forall \ (\{i, i', i''\}, \{i'''\}) \in I_3, j, t \qquad (3\text{-}14)$$

don't fund mutually exclusive MDEP subsets
[fund either subset {i, i', i''} or subset {i'''}, but not both]

b. Complementary Projects

Complementary projects are those MDEP increments that must be funded simultaneously. In the case of pairwise complementary MDEPs, if MDEP i is funded, then MDEP i' must be funded. And, the option of funding neither i nor i' is acceptable. As with the concept of mutually exclusive funding, complementary funding can be extended to several MDEP increments as well as subsets of MDEP increments. The concept of conditional funding of MDEP increments is included here as well where MDEP i is funded only if MDEP i' ***and*** i'' or, in the second case, where MDEP i is funded only if MDEP i' ***or*** i'' is funded.

The following notation is provided for identifying complementary and conditional sets:

I_4: *the set of all complementary MDEP increments ;*

I_5: *the set of all conditional MDEPs (logical "and") ;*

I_6: *the set of all conditional MDEPs (logical "or")*

Equations 3-15 through 3-17 depict the three types of complementary and conditional funding relationships formulated for this model.

$$Z_{ij} = Z_{i'j} \;\; ; \; \forall \, (i, i') \in I_4, j, t \tag{3-15}$$

fund complementary MDEPs
*[fund MDEP **i** and MDEP **i'**, or neither]*

$$2Z_{ij} - Z_{i'j} - Z_{i''j} \;\leq\; 0 \;\; ; \; \forall \, (i, i', i'') \in I_5, j, t \tag{3-16}$$

fund conditional MDEPs
*[fund MDEP **i only if** MDEP **i' and i''** are funded]*

$$-2 \;\leq\; Z_{ij} - Z_{i'j} - Z_{i''j} \;\leq\; 0 \;\; ; \; \forall \, (i, i', i'') \in I_6, j, t \tag{3-17}$$

fund conditional MDEPs
*[fund MDEP **i only if** MDEP **i' or i''** is funded]*

c. *Subordinate Projects*

Subordinate projects are those MDEP increments that are funded or not funded based on the conditional funding of one or several other projects. As with the previous formulations, the concept of subordinate funding can be extended to include subsets of several MDEP increments.

The following notation is provided for identifying pairwise and multi-subordinate sets:

I_7: *the set of all pairwise subordinate MDEP increments ;*

I_8 *the set of all multi-subordinate MDEPs (logical "and") ;*

I_9: *the set of all multi-subordinate MDEPs (logical "or")*

Equations 3-18 through 3-20 depict the three types of subordinate funding relationships formulated for this model.

$$Z_{ij} \geq Z_{i'j} \;\; ; \; \forall \, (i, i') \in I_7, j, t \qquad \textit{(3-18)}$$

don't fund pairwise subordinate MDEPs
*[if MDEP **i** is not funded, then don't fund MDEP **i'**]*

$$2Z_{i''j} \geq Z_{ij} + Z_{i'j} \; ; \; \forall \, (i, i', i'') \in I_8, j, t \qquad \textit{(3-19)}$$

fund multi-subordinate MDEPs
*[if MDEP **i or i'** is funded, then must fund MDEP **i''**]*

$$Z_{i''j} \geq Z_{ij} + Z_{i'j} - 1 \; ; \; \forall \, (i, i', i'') \in I_9, j, t \qquad \textit{(3-20)}$$

fund multi-subordinate MDEPs
*[if MDEP **i and i'** are funded, then must fund MDEP **i''**]*

F. ACHIEVEMENT FUNCTION

1. Formulation

The achievement function for the optimization of TRADOC's RDA investment funds contains all of the weighted and scaled deviations from the aspiration levels of each of the modernization goals. Since the *ideal* solution would contain no deviations from the desired aspiration levels, the optimal solution will be one that *minimizes* these deviations based on the relative importance of the goals and the corresponding deviation penalties. These input values must be carefully determined by the decision maker and may be varied to examine model sensitivities. The algebraic representation of the achievement function is given in Equation 3-21.

$$
\begin{aligned}
&\sum_t WEIGHT1_t\, NWARVAL_t \;+\; \sum_k \sum_t WEIGHT2_t\, NBAL1_{kt} \\
&+ \sum_k \sum_t WEIGHT3_t\, NBAL2_{kt} \;+\; \sum_k \sum_t WEIGHT2_t\, PBAL1_{kt} \\
&+ \sum_k \sum_t WEIGHT3_t\, PBAL2_{kt} \;+\; \sum_i \sum_j \sum_t \frac{WEIGHT4_t}{SCALTURB} NTURB_{ijt} \\
&= DEVIATION \qquad (3\text{-}21)
\end{aligned}
$$

IV. MODEL IMPLEMENTATION AND ANALYSIS OF RESULTS

A. MODEL IMPLEMENTATION

The GAMS formulation of the model developed in Chapter III is included in Appendix A. The model, entitled **FORCEMOD**, imports all required sets, scalars, parameters, and tables through three **INCLUDE** files called **SET**, **PAR**, and **DAT**. Logical constraints are imported into the model through a fourth **INCLUDE** file, called **LGC**. Post-optimization summary reports are created through the implementation of a separate file, called **REP**, located at Appendix B. All of the input files, and the report file, are formatted using GAMS terminology and syntax. Although these files are external to the GAMS model, enabling the user to rapidly modify budget and warfighting parameters without entering the base model environment, the GAMS terminology and syntax must be adhered to in composing these files.

A representative, unclassified database, used for TRADOC's LRAMRP cycle FY94-08, was provided by TRAC-OAC for model examination and analysis. It consisted of the aspired funding profile for 257 separate MDEP increments for the fifteen fiscal years of the FY94-08 programming cycle, along with the warfighting value, proponent TRADOC mission area, and operation and support costs of each. Additionally, TRAC-OAC provided budget and funding data for the budgetary and warfighting parameters used in the model. A representative sample of desired funding relationships was also provided to formulate the logical constraints. The **SET**, **PAR**, **DAT**, and **LGC** files developed from this database are located in Appendix C.

1. Summary Reports

The following is a list of post-optimization summary reports that are generated after each model run by implementing the **REP** file:

- *Breakdown of the Objective Function*
- *Report of Funding by Mission Area*
- *Mission Area Balance Report*
- *Warfighting Value by Fiscal Year*
- *Funded MDEP Increments*
- *Unfunded MDEP Increments*
- *Excluded MDEP Increments*
- *Mission Area Funding as a Percentage of Annual Budget*
- *Funding Turbulence*

These reports allow analysts and decision makers to rapidly examine the impacts of various input parameters and logical constraints and ultimately, to develop an acceptable investment strategy suiting the Army's modernization needs. These concise reports are quickly generated, providing a comprehensive breakout of critical factors that influence TRADOC's budgeting recommendations concerning total Army mission effectiveness. More importantly, these reports can be easily modified using GAMS syntax to report any additional information necessary for investment analysis.

B. ANALYSIS OF RESULTS

The model was validated by analyzing the effects of varying two critical input parameters, annual budget and goal priorities, on the three modernization goals: *maximize warfighting value, maintain mission area balance,* and *minimize funding turbulence.* The measure of effectiveness (MOE) for each of the goals is defined in Table 9.

TABLE 9. MEASURES OF EFFECTIVENESS

Modernization Goal	Measure of Effectiveness
Maximize Warfighting Value	*actual FY08 warfighting value*
Maintain Mission Area Balance	$\sum_k \lvert\%\ \textit{desired level of funding} - \%\ \textit{actual level of funding}\rvert$
Minimize Funding Turbulence	$\sum_{ijt} NTURB_{ijt}$

Hence, the MOEs for the modernization goals were determined from the post-optimization summary reports generated after each model run. These values were then summarized in tables for analysis and discussion. The actual summary reports for the constrained and unconstrained budget runs are included in Appendices D and E respectively. But, due to the volume of the summary reports generated for each run, the results of the six runs made for analyzing the effects of varying goal priorities are not included as appendices. Rather, the MOE values were extracted from the reports and summarized in tables.

1. Varying the Annual Budget

In a capital budgeting environment, the dollars budgeted for each fiscal year are typically the most influential, and the most sensitive, model parameters. Hence, to analyze the maximum return on the Army's investment dollars, two separate model runs were conducted, each with a distinct funding profile representing TRADOC's annual RDA budget allocation. The modernization goal was given a much higher weight, almost 70%, than the mission area balance and turbulence goals. These weights, as well as all other funding and warfighting values were held constant for both runs. The first run, conducted with a *constrained* budget, consisted of a budget stream of $10 billion dollars for each of the first five fiscal years, $11 billion dollars for each of the second five fiscal years, and $12 billion dollars for each of the last five fiscal years. The summary reports for this constrained run, including the optimal funding levels derived for each of the MDEP increments, are included in Appendix D. The *unconstrained* run was conducted with an unrealistically high budget of $20 billion dollars for each fiscal year. This figure was used because it exceeds the total aspirations over all projects. The summary reports for this run are located in Appendix E.

The resulting MOE values for each of the modernization goals, as well as the amount of unspent dollars and number of unfunded projects for each of the runs, are included below in Table 10.

TABLE 10. RESULTS OF BUDGET- CONSTRAINED AND UNCONSTRAINED RUNS

Modernization Goal	**MOE** *constrained run*	**MOE** *unconstrained run*
Maximize Warfighting Value	770.924	774.050
Maintain Mission Area Balance	25.61	25.07
Minimize Funding Turbulence	12.968	0.000
% of Budget Unspent	4.1	40.8
# of Unfunded Projects	25	19

These results indicate the interesting fact that no matter how much money is available, there will still be unfunded projects and unspent budget dollars, given that all other factors and parameters remain constant. The constrained budget run resulted in $6.8 billion unspent dollars across only the last five years of the programming cycle with a total of 25 unfunded projects; whereas the unconstrained run resulted in nineteen unfunded projects across the entire fifteen year time horizon. Several MDEP increments remain unfunded strictly due to the restricted funding relationships created by the logical constraints. Additionally, the amount of unspent dollars within a given fiscal year, if any, can be explained by the aspired funding profile of the MDEP increments across the time horizon and the minimum incremental funding constraints. MDEP increments which cannot be funded at their minimum incremental funding level don't get funded at all. Hence, MDEP increments that have a non-turbulent aspired funding profile that starts early in the programming cycle have a better chance of being funded than those increments that have small aspirations initially with large aspirations in the last five years.

Table 10 also indicates a slightly better warfighting value with an unconstrained budget. This intuitive result stems from the availability of more dollars to fund MDEP increments with only partial funding in the constrained case. However, this additional warfighting value contributing to total Army mission effectiveness is relatively small. Virtually no improvement in the mission area balance goal resulted from the unconstrained run, however, there was no turbulence in the funding profile. The concept of non-turbulent funding refers to the fractional funding levels of a given MDEP increment in two consecutive fiscal years in which funding was aspired. For the purpose of this analysis, a ramp-up funding factor of 90% (i.e., $RAMP_{ij} = 0.90$) was held constant. Hence, for any MDEP increment, the value of X_{ijt} should be greater than or equal to 90% of X_{ijt-1}, the fraction of aspired level of funding allocated in the previous fiscal year. Since this is a model goal, this desired relationship for an MDEP increment in a given fiscal year can be violated, with the amount of positive or negative deviation equalling the value of $NTURB_{ijt}$.

A significant observation in the composite results of the constrained and unconstrained runs is the percent of budget dollars that remained unspent in the programming cycle. For the constrained run, 4.1% of the available dollars were unspent and this occurred in the last five fiscal years. The annual budget in each of the previous ten fiscal years was completely spent. Although the annual budget figure was intentionally set unrealistically high for the unconstrained budget analysis, this would represent an unacceptable investment strategy. Operationally, in the LRAMRP environment, it is more important to spend fiscal dollars efficiently in the early years than in the out years since annual budgets are more clearly defined in the early years.

This summary and analysis of the constrained and unconstrained budget runs indicate that the model returns *face valid* results to the decision maker. In this comparative case, the marginal utility of a funding strategy that yields a slightly more balanced, totally non-turbulent profile, and a slightly higher total warfighting value, would not justify 40.8% of uncommitted investment funds.

2. Varying the Goal Priorities

The power of the weighted linear goal programming formulation lies in the decision maker's ability to assign weights for the modernization goals. Hence, by assessing the goal priorities, the decision maker establishes the penalties associated with violations of each goal's aspiration level. It follows then that a second step in examining the model involved an analysis of varying the goal priorities. Specifically, three model runs were conducted, optimizing a different goal each run. For each run, the goal to be optimized received a value of 0.9999. The other two goals received almost no weight with values of 0.00005. The original constrained budget profile was used and all other model parameters were held constant. After each run, the MOE for each of the modernization goals was determined using the definitions in Table 9. The results of sequentially optimizing each of the goals, and the corresponding achievement levels of the MOEs, are summarized below in Table 11.

TABLE 11. SUMMARY REPORT OF OPTIMIZING THE MODERNIZATION GOALS

Objective	Achievement Level *Warfighting Goal*	Achievement Level *Balance Goal*	Achievement Level *Turbulence Goal*
Maximize Warfighting Goal	***770.924**	25.61	12.968
Minimize Balance Goal	700.142	***14.62**	37.125
Minimize Turbulence Goal	770.295	24.04	***0.000**

The asterisked achievement levels under each modernization goal indicate the optimal value for that goal using the FY94-08 LRAMRP database described at the beginning of this chapter. As was expected, the optimal achievement level for each goal was attained when that goal was given nearly all of the priority. Once again, this confirms that the model is operating as expected and producing face valid results. It appears that weighting the turbulence goal heavily results in the best overall funding strategy consisting of no funding turbulence, relatively balanced funding across the TRADOC mission areas, and almost the maximum achievable warfighting value. On the other hand, optimizing the balance goal results in the worst achievement levels for both the warfighting goal and the turbulence goal.

Table 12 summarizes the percent of total budget that was unspent and the number of unfunded projects that resulted from the optimization of each warfighting goal.

TABLE 12. SUMMARY OF FUNDING EFFICIENCY

Objective	% of Budget Unspent	# of Unfunded Projects
Maximize Warfighting Goal	4.1	25
Minimize Balance Goal	12.7	41
Minimize Turbulence Goal	5.5	27

From strictly a funding perspective, it appears that optimizing the warfighting goal yields the most efficient use of the Army's investment dollars, although the results of the turbulence goal are only marginally different. Conversely, designing an investment strategy solely based on mission area balance yields seemingly unacceptable results.

Table 11 also highlights that regardless of the weight placed on the warfighting goal, there is a relatively small variance in level of achievement. Upon further investigation, thirteen projects were unfunded in all three of the goal optimization runs, eight of which were dictated by the logical constraints. Consequently, this emphasizes the influence of the logical constraints and their impact on developing investment strategies. Hence, the logical constraints require careful formulation by the decision maker.

Additional analysis was conducted to examine the effects of holding the value of the warfighting goal constant while varying the levels of the balance and turbulence goals. In this approach, the warfighting goal was given a constant weight of 0.1 for each of three runs, while the sum of the weights of the balance and turbulence goals summed to 0.9 in various combinations. For the first run, the weight of the balance goal was set at 0.25 and the weight of the turbulence goal was set at 0.65. In the second run, the weights of the balance and turbulence goals were both set at 0.45. Finally, in the third run, the balance goal was assigned a weight of 0.65 while the turbulence goal was assigned a weight of 0.25. Again, the original constrained budget profile was used while all other model parameters were held constant. Tables 13 summarizes the results of these optimization runs.

TABLE 13. SUMMARY REPORT OF VARYING THE GOAL PRIORITIES

Run #	Goal Weights warfighting/balance/turbulence	Achievement Level *Warfighting Goal*	Achievement Level *Balance Goal*	Achievement Level *Turbulence Goal*	% of Budget Unspent	# of Unfunded Projects
1	0.1/0.25/0.65	*770.798	24.82	*14.438	*5.8	*25
2	0.1/0.45/0.45	770.660	23.88	15.683	6.3	26
3	0.1/0.65/0.25	770.419	*22.11	14.723	8.9	28

The asterisked achievement levels indicate the best value of the three runs. These results appear consistent with those of the initial runs optimizing one modernization goal at a time. While holding the weight of the warfighting goal constant, the best return on the Army's investment dollar resulted from weighting the turbulence goal higher than the balance goal. The weighting scheme portrayed in the first run also produced the least turbulent funding profile, the least number of unfunded projects, and the smallest percentage of unspent investment dollars. Although the achievement level of the balance goal in the first run was the least appealing of the three runs, it differed from the best value in run three by only 2.71. In fact, the balance goal achievement level was the only "best value" for run three, where the balance goal was weighted higher than the turbulence goal. The remaining values reflected the percent of unspent budget, number of unfunded projects, and warfighting value were least favorable for the third of the three runs. The achievement level of the turbulence goal for this run was only marginally better than the worst value achieved in run two. Moreover, when the balance and turbulence goals were weighted equally in run two, the results were better than run three in three out of five reported categories. Hence, the second weighting scheme produced the second best results of the three runs, with the sole least favorable value occurring in the turbulence goal.

V. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this final chapter is to briefly present the conclusions drawn from the results and analysis of the multiple objective capital budgeting model, FORCEMOD, developed in this thesis, as well as state the recommendations for further research motivated by this study.

A. CONCLUSIONS

The model was demonstrated and delivered to the user in June of 1992, during the 60th MORS Symposium held at the Naval Postgraduate School. The response from Fort Leavenworth on the capabilities of the model and its potential use at TRADOC and Department of the Army levels has been very positive. The model and its capabilities will be demonstrated to the TRAC commander in September of 1992 at Fort Leavenworth. The following conclusions have been observed:

First, ***the model is responsive***. FORCEMOD produces timely, *face valid* funding strategies. The weighted linear goal programming formulation of the multiple objective goal programming problem provides the decision maker fast prototyping capability in designing investment strategies for LRAMRP planning and programming cycles. By implementing the model with GAMS and the XA solver [Ref. 20], FORCEMOD has repeatedly allocated a $165 billion dollar modernization investment by determining the optimal funding levels of over 250 MDEP increments across a fifteen year time horizon, with varying input parameters and goal weights, in less than fifteen minutes. The GAMS and XA software are commercially available hence, the Army can purchase them off-the-shelf at reasonable cost. Additionally, the post-optimization summary reports provide the analyst and decision maker with concise, informative reports that present the achievement levels of all major aspects of the budgeting framework for which decisions will be made, thereby expediting any tradeoff analysis that must be conducted.

Second, ***the model is flexible***. FORCEMOD's inherent flexibility provides the capability to rapidly modify the values of the input parameters based on the desires of the decision maker. Additionally, the model can quickly determine the effects of changing these parameter values, as well as the aspiration levels of the model goals and the relative priorities of each.

Finally, ***the model is versatile***. The relational database methods and mathematical principles of the GAMS formulation provide the capability to rapidly modify the model and its database to reflect the specifications and framework of any capital budgeting environment at TRADOC and Department of the Army levels. Furthermore, FORCEMOD's portability, self-documentation, and post-optimization report writing features completely satisfy the needs of the sponsor for this study. Above all, the effects of maximizing warfighting value, while minimizing funding turbulence and maintaining mission area balance, allow inter- and intra- goal tradeoffs in the LRAMRP process that produce optimal investment strategies previously unattainable through the sponsor's use of a heuristic algorithm. Thus, the model proposed in this thesis may greatly assist TRADOC in its role as architect of the future Army, thereby enhancing the future vision of how the Army will fight, ensuring total mission effectiveness in the 21st century with maximum warfighting capability.

B. RECOMMENDATIONS FOR FURTHER RESEARCH

1. Generic Modeling of the Logical Constraints

The logical constraints are currently formulated specifically, in contrast to all other constraints which are formulated generically, as permitted by an algebraic modeling language like GAMS. The user must type each of these constraints individually. Depending on the number of logical constraints, this could become unwieldy. Employment of advanced database representation and programming techniques may permit the coding of MDEP increments within the database itself to allow generic modeling of the logical constraints for direct translation into the model. Although this technique may complicate the format of the input database, it would alleviate the task of typing the logical constraints separately and possibly eliminate the potential for multiple syntax errors.

2. Graphic Representation of Post-Optimization Summary Reports

The model produces a number of post-optimization summary reports, in tabular format, that provide the necessary insights for developing long-term investment strategies. A possible enhancement to this format would be the implementation of spreadsheets which could then be interfaced with comprehensive, leading edge charting, drawing, and presentation graphics software. This would allow alternative graphical representations of the model results to suit analysts and decision makers at all levels of command. More importantly, this would provide virtually unlimited application of several statistical and data analysis tools and techniques, thereby assisting those analysts and decision makers in making challenging investment decisions in the Army's complex budgeting environment.

APPENDIX A. GAMS FORMULATION

```
$TITLE Optimization Model for Army Planning and Programming
$offupper offsymxref offsymlist offuellist inlinecom{ }
*-----------------------------------------------------------------------------*
$ONTEXT

   FORCEMOD is a flexible, responsive, multi-objective, weighted goal
   programming, optimization model that assists in the selection of a set of
   competing candidate Army modernization actions, called management
   decision packages (MDEPs), that maximize potential warfighting benefits,
   subject to national and Department of the Army goals and objectives.

   Formulated April 92 - June 92 by:

                  Analyst:   CPT Scott F. Donahue
                  Advisor:   Dr. Richard E. Rosenthal, Code OR/Rl
                             Naval Postgraduate School
                             Monterey, CA  93943-5000
                             (408) 646-2795

$OFFTEXT
*-----------------------------------------------------------------------------*

 OPTIONS
       limrow      =    0
       limcol      =    0
       solprint    =   off
       mip         =    xa
       rmip        =    xa
       optcr       =   0.1
       optca       =    0
       iterlim     = 50000
       reslim      = 10000
       integer1    =   101
       integer2    =   122
       ;
```

```
SETS

        i   management decision package (MDEP)

        j   number of increment levels of MDEP I
                / 01, 02, 03, 04, 05, 06, 07, 08, 09, 10 /

        k   users (TRADOC mission areas)

        t   fiscal years in the time horizon
        ;

ALIAS (t,tt) ;

$INCLUDE FORCEMOD.SET

$INCLUDE FORCEMOD.PAR

$INCLUDE FORCEMOD.DAT

SET IJ(i,j)                     mapping of allowable MDEP increments ;
*                               all allowable increments J are mapped
*                               to a respective MDEP I

        IJ(i,j) = YES $ SUM( k, MDEPDATA(i,j,k,"VALUE") ) ;

SET MSNAREA(i,j,k)              map of MDEP increment to mission area ;
*                               the Jth increment of MDEP I is mapped to
*                               its respective TRADOC mission area K

        MSNAREA(i,j,k) = YES $ MDEPDATA(i,j,k,"VALUE") ;

PARAMETER WEIGHT1(t)            discounted weight of warfighting goal ;

        WEIGHT1(t) = POWER(0.995, ORD(t) - 1) * WT1 ;

PARAMETER WEIGHT2(t)            discounted weight of balance goal ;

        WEIGHT2(t) = POWER(0.995, ORD(t) - 1) * WT2 ;
```

```
PARAMETER WEIGHT3(t)        elastic penalty for funding levels ;
*                           weight of elastic penalties assigned to the
*                           negative and positive deviations from the
*                           minimum and maximum mission area
*                           funding levels

     WEIGHT3(t) = 3 * WEIGHT2(t) ;

PARAMETER WEIGHT4(t)        discounted weight of turbulence goal ;

     WEIGHT4(t) = POWER(0.995, ORD(t) - 1) * WT3 ;

PARAMETER ASPIRE(i,j,t)     aspired levels of funding ;
*                           aspired level of funding (Kdollars) for the
*                           Jth increment of MDEP I in fiscal year T

     ASPIRE( IJ(i,j),t ) = SUM( k, MDEPDATA(i,j,k,t) ) ;

PARAMETER TOTASPIRE(i,j)    total aspired funding across time horizon ;

     TOTASPIRE(IJ) = SUM( t, ASPIRE(IJ,t) ) ;

PARAMETER WARVAL(i,j)       composite priority weight factor ;
*                           composite priority weight factor
*                           (AHP warfighting value) for the Jth
*                           increment of MDEP I

     WARVAL(IJ(i,j)) = SUM( k, MDEPDATA(i,j,k,"VALUE") ) ;

SCALAR SCALTURB             turbulence goal scaling factor ;

     SCALTURB = SUM( (IJ,t) $ ( ASPIRE(IJ,t) * ASPIRE(IJ,t-1) ), 1 ) ;

SET EXCLUDE1(i,j)           exclude projects with zero totaspire ;

     EXCLUDE1( IJ(i,j) ) = YES $ ( TOTASPIRE(i,j) EQ 0 ) ;
```

```
SET EXCLUDE2(i,j)               exclude projects with negative aspirations ;

      EXCLUDE2( IJ(i,j) ) = YES $ SUM ( t, ASPIRE(i,j,t) LT 0 ) ;

* Remove projects with no aspirations across the time horizon.

      IJ(i,j) $ ( TOTASPIRE(i,j) EQ 0 ) = NO ;

* WARNING. If any aspirations are negative, project is deleted.

      IJ(i,j) $ SUM ( t, ASPIRE(i,j,t) LT 0 ) = NO ;

PARAMETER OSCOST(i,j)           operation and support costs ;
*                               operation and support costs (Kdollars) for
*                               the Jth increment of MDEP I

      OSCOST( IJ(i,j) ) =  SUM( k,  MDEPDATA(i,j,k,"cat_3" )
    + MDEPDATA(i,j,k,"cat_4")
    + MDEPDATA(i,j,k,"cat_5") ) ;

* If no CAT III, CAT IV, or CAT V costs are given, assume OSCOST
* is 50% of total aspiration.
* (Reference:  Dr. Mike Anderson memo of 28 May 92)

      OSCOST(ij) $ ( OSCOST(ij) EQ 0 ) = 0.5 * TOTASPIRE(ij) ;

SCALAR TOTOSCOST                total operation and support costs ;

      TOTOSCOST = SUM( IJ, OSCOST(ij) ) ;

PARAMETER WARVALU(i,j,t)  cumulative composite weight factor ;
*                         proportional composite priority weight
*                         factor(cumulative AHP warfighting value)
*                         for the Jth increment of MDEP I in fiscal
*                         year T

      WARVALU(IJ,t) = 0 ;
LOOP(t,
      WARVALU(IJ,t) = WARVALU(IJ,t-1)
        + (WARVAL(IJ) * ASPIRE(IJ,t)) / TOTASPIRE(IJ) ;
```

```
PARAMETER MAXWARVAL(t) maximum yearly warfighting value ;
*                      the sum of the proportional composite
*                      prority weight factors for each MDEP
*                      increment is the maximum yearly
*                      warfighting value

      MAXWARVAL(t) = SUM( IJ, WARVALU(IJ,t) ) ;

PARAMETER MANDATE(i,j)  Congressionally mandated MDEPs ;
*                       indicates Congressionally mandated
*                       increments(equals 1 if the Jth increment of
*                       MDEP I is mandated, 0 otherwise)

      MANDATE( IJ(i,j) ) = SUM( k, MDEPDATA(i,j,k,"MAND") ) ;

* List of optional set and parameter displays.

*OPTION IJ:0:0:1              ; DISPLAY IJ          ;
*OPTION WARVAL:2:0:1          ; DISPLAY WARVAL      ;
*OPTION WARVALU:2:2:1         ; DISPLAY WARVALU     ;
*OPTION MAXWARVAL:2:0:1       ; DISPLAY MAXWARVAL   ;
*OPTION OSCOST:0:0:1          ; DISPLAY OSCOST      ;
*OPTION MANDATE:0:0:1         ; DISPLAY MANDATE     ;
*OPTION WEIGHT1:4:0:1         ; DISPLAY WEIGHT1     ;
*OPTION WEIGHT2:4:0:1         ; DISPLAY WEIGHT2     ;
*OPTION WEIGHT3:4:0:1         ; DISPLAY WEIGHT3     ;
*OPTION WEIGHT4:4:0:1         ; DISPLAY WEIGHT4     ;

POSITIVE VARIABLES

      X(i,j,t)              continuous variable for fractional funding
*                           fraction of aspired level of funding for the
*                           Jth increment of MDEP I in fiscal year T

      NWARVAL(t)            negative deviation from warfighting goal
*                           negative deviation from aspired
*                           warfighting value in fiscal year T

      NBAL1(k,t)            negative deviation from balance goal
*                           negative deviation from desired level of
*                           funding for TRADOC mission area K in
*                           fiscal year T
```

```
        NBAL2(k,t)              negative deviation from area funding levels
*                               negative deviation from minimum funding
*                               level of TRADOC mission area K in fiscal
*                               year T

        PBAL1(k,t)              positive deviation from balance goal
*                               positive deviation from desired level of
*                               funding for TRADOC mission area K in fiscal
*                               year T

        PBAL2(k,t)              positive deviation from area funding levels
*                               positive deviation from maximum funding
*                               level of TRADOC mission area K in fiscal
*                               year T


        NTURB(i,j,t)            negative deviation from turbulence goal
*                               negative deviation from stable funding of
*                               the Jth increment of MDEP I in fiscal year T
                                ;

BINARY VARIABLE

        Z(i,j)                  binary variable indicating funding status
*                               binary variable indicating 1 if the Jth
*                               increment of MDEP I is funded and
*                               0 otherwise
                                ;

FREE VARIABLE

        DEVIATION               sum of the weighted and scaled deviations
*                               the sum of the weighted and scaled
*                               deviations from the aspiration levels for
*                               each modernization goal
                                ;

* Fix variables or set bounds as needed.

        X.UP(IJ,t) $ ASPIRE(IJ,t)  = 1.0 ;

        X.FX(IJ,t) $ ( ASPIRE(IJ,t) AND (MANDATE(IJ) EQ 1) ) = 1.0 ;

        Z.FX(IJ) $ ( TOTASPIRE(IJ) AND (MANDATE(IJ) EQ 1) ) = 1.0 ;
```

```
NBAL1.UP(k,t)  =  SHAREDATA(K,"DESIRED") -
     SHAREDATA(K,"MINIMUM") ;

PBAL1.UP(k,t)  =  SHAREDATA(K,"MAXIMUM") -
     SHAREDATA(K,"DESIRED") ;
```

EQUATIONS

*** modernization goals**

```
WARVALUE(t)          achieve desired warfighting value
BALANCE(k,t)         maintain mission area balance
TURBULENCE(i,j,t)    minimize funding turbulence
```

*** system constraints**

```
MODCOST(t)           adhere to yearly budgetary restrictions
SUSTAIN              adhere to maximum operation and support cost
LINKAGE(i,j,t)       link discrete and continuous decision variables
FRACFUND(i,j)        adhere to minimum incremental funding levels
INCREMENT(i,j)       fund MDEPs incrementally
```

*** objective**

```
OBJDEF               objective function ;
```

*** formulation of modernization goals**

```
WARVALUE(t)..
     SUM( IJ, ( WARVAL(IJ) / TOTASPIRE(IJ) )  *
        SUM( tt $ ( ORD(tt) LE ORD(t) ), ASPIRE(IJ,tt) * X(IJ,tt) ) )
  + NWARVAL(t) =E= MAXWARVAL(t) ;

BALANCE(k,t)..
     SUM( (IJ) $ MSNAREA(IJ,k), X(IJ,t) * ASPIRE(IJ,t) ) / BUDGET(t)
  + NBAL1(k,t) + NBAL2(k,t) - PBAL1(k,t) - PBAL2(k,t)
  =E= SHAREDATA(K,"DESIRED") ;

TURBULENCE(IJ,t) $ ( ASPIRE(IJ,t) * ASPIRE(IJ,t-1) )..
     X(IJ,t) =G= RAMP(IJ) * X(IJ,t-1) - NTURB(IJ,t) ;
```

* formulation of system constraints

```
MODCOST(t)..
      SUM( (IJ), X(IJ,t) * ASPIRE(IJ,t) ) / BUDGET(t) =L= 1 ;

SUSTAIN..
      SUM( IJ, OSCOST(IJ) * ( SUM( t, X(IJ,t) *ASPIRE(IJ,t)
         / TOTASPIRE(IJ) ) ) ) / TOTOSCOST   {Scaling constant}
  =L= MAXOSCOST / TOTOSCOST ;

LINKAGE( IJ(i,j),t ) $ ASPIRE(i,j,t)..
      X(IJ,t) =L= Z(IJ) ;

FRACFUND( IJ(i,j) )..
      SUM( t, X(IJ,t) * ASPIRE(IJ,t) ) / TOTASPIRE(IJ)
  =G= MINLEVEL(j) * Z(IJ) ;

INCREMENT( IJ(i,j) ) $ ( (ORD(j) GT 1) $ IJ(i,"01") )..
      Z(i,"01") =G= Z(i,j) ;
```

$INCLUDE FORCEMOD.LGC

* formulation of objective

```
OBJDEF..        SUM( t, WEIGHT1(t) * NWARVAL(t) )
              + SUM( (k,t), WEIGHT2(t) * NBAL1(k,t) )
              + SUM( (k,t), WEIGHT3(t) * NBAL2(k,t) )
              + SUM( (k,t), WEIGHT2(t) * PBAL1(k,t) )
              + SUM( (k,t), WEIGHT3(t) * PBAL2(k,t) )
              + SUM( (IJ,t) $ (ASPIRE(IJ,t) * ASPIRE(IJ,t-1) ),
                    WEIGHT4(t) * NTURB(IJ,t) ) / SCALTURB
            =E= DEVIATION ;
```

MODEL FORCEMOD /ALL/ ;

SOLVE FORCEMOD USING MIP MINIMIZING DEVIATION ;

APPENDIX B. GAMS REPORT FILE

```
*****************************************************************
**     Optimization Model for Army Planning and Programming     **
**              Post-Optimization Summary Reports               **
*****************************************************************

$offupper offsymxref offsymlist offuellist offlisting

*****************************************************************
**               Breakdown of Objective Function                **
*****************************************************************

PARAMETER OBJREP(*)          Breakdown of objective function ;
OBJREP("WARVAL")   = SUM( t, WEIGHT1(t) * NWARVAL.L(t) ) ;
OBJREP("NBAL1")    = SUM( (k,t), WEIGHT2(t) * NBAL1.L(k,t) ) ;
OBJREP("PBAL1")    = SUM( (k,t), WEIGHT2(t) * PBAL1.L(k,t) ) ;
OBJREP("NBAL2")    = SUM( (k,t), WEIGHT3(t) * NBAL2.L(k,t) ) ;
OBJREP("PBAL2")    = SUM( (k,t), WEIGHT3(t) * PBAL2.L(k,t) ) ;
OBJREP("NTURB")    = SUM( (IJ,t) $ (ASPIRE(IJ,t) * ASPIRE(IJ,t-1) ),
                       WEIGHT4(t) / SCALTURB * NTURB.L(IJ,t) ) ;
OBJREP("TOTAL")    = DEVIATION.L ;
OPTION OBJREP:4:0:1 ;
DISPLAY OBJREP ;


*****************************************************************
**             Post-Optimization Summary Parameters             **
**    (Funding Parameters Expressed in Thousands of Dollars)    **
*****************************************************************

PARAMETER  TOTFUND(i,j)     total funding allocated to MDEP-increment
           MISNFUND(k,t)    funding given to mission area by fiscal year
           TOTYEARF(t)      total funding by fiscal year
           TOTYEARA(t)      total funding aspired by fiscal year
           TOTMISNF(k)      total funding given to mission area
           TOTMISNA(k)      total funding aspired by mission area
           TOTASK           total funding requested
           TOTSPEND         total funding allocated
           TOTBUDGET        total budget
           ;
```

```
TOTFUND(IJ)        = SUM( t, X.L(IJ,t) * ASPIRE(IJ,t) ) ;
MISNFUND(k,t)      = SUM( IJ $ MSNAREA(IJ,k), X.L(IJ,t) * ASPIRE(IJ,t) ) ;
TOTYEARF(t)        = SUM( k, MISNFUND(k,t) ) ;
TOTYEARA(t)        = SUM( IJ, ASPIRE(IJ,t) ) ;
TOTMISNF(k)        = SUM( t, MISNFUND(k,t) ) ;
TOTMISNA(k)        = SUM( IJ $ MSNAREA(IJ,k), TOTASPIRE(IJ) ) ;
TOTASK             = SUM( k, TOTMISNA(k) ) ;
TOTSPEND           = SUM( k, TOTMISNF(k) ) ;
TOTBUDGET          = SUM( t, BUDGET(t) ) ;

*************************************************************************
**              Summary Report of Funding by Fiscal Year              **
*************************************************************************

PARAMETER  YEARSUM(*,*)        Summary Report of Funding by Fiscal Year ;
YEARSUM(t,"TOTASPIRE")  =  TOTYEARA(t) ;
YEARSUM(t,"TOTFUND")    =  TOTYEARF(t) ;
YEARSUM(t,"BUDGET")     =  BUDGET(t) ;
YEARSUM(t,"UNSPENT")    =  ROUND( BUDGET(t) - TOTYEARF(t) ) ;
OPTION YEARSUM:0:1:1 ;
DISPLAY YEARSUM ;

*************************************************************************
**              Summary Report of Funding by Mission Area             **
*************************************************************************

PARAMETER  MISNSUM(*,*)        Summary Report of Funding by Mission Area ;
MISNSUM(k,"TOTASPIRE")    =  TOTMISNA(k) ;
MISNSUM(k,"TOTFUND")      =  TOTMISNF(k) ;
MISNSUM(k,"PCT-FUNDED")   =  100 * TOTMISNF(k) / TOTMISNA(k) ;
MISNSUM(k,"PCT-BUDGET")   =  100 * TOTMISNF(k) / TOTBUDGET ;
MISNSUM(k,"PCT-ALLOC")    =  100 * TOTMISNF(k) / TOTSPEND ;
MISNSUM("UNSPENT","TOTFUND")  =
                     ROUND ( TOTBUDGET - TOTSPEND ) ;
MISNSUM("TOTAL","TOTASPIRE")     =  TOTASK ;
MISNSUM("TOTAL","TOTFUND")       =  TOTSPEND ;
MISNSUM("TOTAL","PCT-FUNDED")    =  100 * TOTSPEND / TOTASK ;
MISNSUM("BUDGET","TOTFUND")      =  TOTBUDGET ;
MISNSUM("BUDGET","PCT-BUDGET")   =  100 ;
MISNSUM("TOTAL","PCT-BUDGET")    =  100 * TOTSPEND / TOTBUDGET ;
MISNSUM("TOTAL","PCT-ALLOC")     =  100 ;
MISNSUM("UNSPENT","PCT-BUDGET")  =  100 * (1 - TOTSPEND /
                     TOTBUDGET) ;
```

```
OPTION MISNSUM:1:1:1 ;
DISPLAY MISNSUM ;

*************************************************************************
**                Summary Report of Mission Area Balance                **
*************************************************************************

PARAMETER BALSUM(*,*)          Summary Report of Mission Area Balance ;
BALSUM(k,"PCT-ASPIRE")    = 100 * TOTMISNA(k) / TOTASK ;
BALSUM(k," DESIRED")      = 100 * SHAREDATA(k,"DESIRED") ;
BALSUM(k," PCT-ALLOC")    = 100 * TOTMISNF(k) / TOTSPEND ;
OPTION BALSUM:2:1:1 ;
DISPLAY BALSUM ;

*************************************************************************
**           Summary Report of Warfighting Value by Fiscal Year         **
*************************************************************************

PARAMETER WARREP(*,*)          Summary of Warfighting Value ;
WARREP(t,"IDEAL")         = MAXWARVAL(t) ;
WARREP(t,"ACTUAL")        = MAXWARVAL(t) - NWARVAL.L(t) ;
DISPLAY WARREP ;

*************************************************************************
**              Summary Report of Funded MDEP Increments                **
*************************************************************************

PARAMETER FUNDREP(*,*,*)               Summary Report of Funded Projects ;
FUNDREP(IJ,"TOTASPIRE") $ TOTFUND(IJ) = TOTASPIRE(IJ) ;
FUNDREP(IJ,"TOTFUND")                 = TOTFUND(IJ) ;
FUNDREP(IJ,"PCT-FUNDED") = 100 * TOTFUND(IJ) / TOTASPIRE(IJ) ;
FUNDREP("TOTAL","FUNDED","TOTASPIRE")     =
                       SUM( IJ, TOTASPIRE(IJ) ) ;
FUNDREP("TOTAL","FUNDED","TOTFUND") = SUM( IJ, TOTFUND(IJ) ) ;
FUNDREP("TOTAL","FUNDED","PCT-FUNDED")   =
            100 * SUM( IJ, TOTFUND(IJ) ) / SUM( IJ, TOTASPIRE(IJ) ) ;
FUNDREP("TOTAL","FUNDED","WAR-VALUE")   =
                       SUM( IJ, FUNDREP(IJ,"WAR-VALUE") ) ;
FUNDREP("TOTAL","FUNDED","OS-COST") =
                       SUM( IJ, FUNDREP(IJ,"OS-COST") ) ;
OPTION FUNDREP:2:2:1 ;
DISPLAY FUNDREP ;
```

```
*************************************************************************
**            Summary Report of Unfunded MDEP Increments              **
*************************************************************************

PARAMETER UNFUNDREP(*,*,*)     Summary Report of Unfunded Projects ;
UNFUNDREP(IJ,"TOTASPIRE") $ ( TOTFUND(IJ) EQ 0 )  = TOTASPIRE(IJ) ;
UNFUNDREP(IJ,"UNFUNDED") $ ( TOTFUND(IJ) EQ 0 ) = 1 ;
UNFUNDREP(IJ,"WARVAL") $ ( TOTFUND(IJ) EQ 0 )     = WARVAL(IJ) ;
UNFUNDREP("TOTAL","UNFUNDED","TOTASPIRE") =
                        SUM( IJ $( TOTFUND(IJ) EQ 0 ), TOTASPIRE(IJ) ) ;
UNFUNDREP("TOTAL","UNFUNDED","WARVAL")    =
                        SUM( IJ $( TOTFUND(IJ) EQ 0 ), WARVAL(IJ) ) ;
UNFUNDREP("TOTAL","UNFUNDED","UNFUNDED") =
                        SUM( ij $( TOTFUND(IJ) EQ 0 ), 1 ) ;
OPTION UNFUNDREP:2:2:1 ;
DISPLAY UNFUNDREP ;


*************************************************************************
**            Summary Report of Excluded MDEP Increments              **
*************************************************************************

SET EXC(i,j) ;
EXC(i,j) = EXCLUDE1(i,j) + EXCLUDE2(i,j) ;

PARAMETER EXCLUDREP(*,*,*)     Summary Report of Excluded Projects ;
EXCLUDREP(EXC,"TOTASPIRE")   = TOTASPIRE(EXC) ;
EXCLUDREP(EXC,"EXCLUDED")    = 1 ;
EXCLUDREP(EXC,"WARVAL")      = WARVAL(EXC) ;
EXCLUDREP("TOTAL","EXCLUDED","TOTASPIRE")  =
                          SUM( EXC, TOTASPIRE(EXC) ) ;
EXCLUDREP("TOTAL","EXCLUDED","EXCLUDED")   =
                          CARD(EXC) ;
EXCLUDREP("TOTAL","EXCLUDED","WARVAL")     =
                          SUM( EXC, WARVAL(EXC) ) ;
OPTION EXCLUDREP:2:2:1 ;
DISPLAY EXCLUDREP ;
```

```
************************************************************************
**              Summary Report of Mission Area Funding                **
**                as a Percentage of Annual Budget                    **
************************************************************************

PARAMETER MISNREP(*,*,*)   Funding Report by Mission Area as Per Cent of Budget ;
MISNREP(t,k,"MINIMUM")   =  100 * SHAREDATA(k,"MINIMUM") ;
MISNREP(t,k,"DESIRED")   =  100 * SHAREDATA(k,"DESIRED") ;
MISNREP(t,k,"MAXIMUM")   =  100 * SHAREDATA(k,"MAXIMUM") ;
MISNREP(t,k,"ACTUAL")    =  100 * MISNFUND(k,t) / BUDGET(t) ;
MISNREP(t,k,"DEVIATION") =
      MAX( 0, MISNREP(t,k,"ACTUAL") - MISNREP(t,k,"MAXIMUM") )
    - MAX( 0, MISNREP(t,k,"MINIMUM") - MISNREP(t,k,"ACTUAL") ) ;

MISNREP(t,"UNSPENT","ACTUAL") =
   ROUND( 100 * ( BUDGET(t) - SUM(k, MISNFUND(k,t) ) ) / BUDGET(t) ) ;
OPTION MISNREP:2:1:1 ;
DISPLAY MISNREP ;

************************************************************************
**                Summary Report of Funding Turbulence                **
************************************************************************

PARAMETER TURBREP(*,*,*,*)                    Report of Funding Turbulence ;
TURBREP(IJ,t,"X(IJ,T-1)") $ NTURB.L(IJ,t)  = X.L(IJ,T-1) ;
TURBREP(IJ,t,"X(IJ,T)") $ NTURB.L(IJ,t)    = X.L(IJ,T) ;
TURBREP(IJ,t,"NTURB")                      = NTURB.L(IJ,T) ;
OPTION TURBREP:3:3:1 ;
DISPLAY TURBREP ;

OPTION X:3:2:1
DISPLAY X.L ;
```

APPENDIX C. GAMS INPUT FILES

INCLUDE File FORCEMOD.SET for Model Indices

```
SET   t                 fiscal years in the time horizon

      / FY94, FY95, FY96, FY97, FY98, FY99, FY00, FY01, FY02, FY03, FY04
        FY05, FY06, FY07, FY08  / ;


SET   k                 TRADOC mission areas

      / COM, C2, IEW, EMW, AD, FS, CSS, AVN, CCL, CCH, NBC  / ;


SET   i                 Management Decision Packages (MDEPs)
*                       "01" increments only

      / ACE3, FA0A, FL6P, FL6Q, FL6V, FL6X, FL6Y, FL8D, FL8G, FPAV,
        FPDA, FPDB, FPDC, FPDD, FPDE, FPDF, FPDG, FPDH, FPDK, FPDL,
        FPDM, FPDP, FPDQ, FPEA, FPED, FPEE, FPEF, FPEG, FPEH, FPEL,
        FPEM, FPEN, FPEP, FPEQ, FPFB, FPFC, FPFJ, FPFK, FPFL, FPFM,
        FPFP, FPGA, FPHB, FPHC, FPHD, FPHE, FPJA, FPJB, FPJC, FPLB,
        FPLC, FPLE, FPLF, FPLG, FPLK, FPLX, FPLZ, FPMA, FPMB, FPMC,
        FPMD, FPMH, FPMJ, FPMK, FPMM, FPNA, FPNB, FPNC, FPNE,
        FPNF, FPNG, FPNH, FPSA, FPSB, FPSD, FPSE, FPSF, FPSG, FPSH,
        FPSJ, FPSL, FPWB, FPWC, FPWD, FPXK, FPXX, FS01, FTMD, LARM,
        LONG, MPKA, MPTK, MPTL, MPTM, MS2B, MS5S, MT1A, MT1D,
        MT1G, MT1L, MT5Y, MX5T, NEW, PEWE, RA02, RA08, RA09,
        RA11, RA14, RA18, RA31, RB03, RB04, RB07, RB08, RB12, RB14,
        RB16, RB21, RB25, RC01, RC02, RC04, RD06, RD07, RD12, RD13,
        RD15, RD16, RD17, RD18, RD19, RD22, RE02, RF01, RF02, RF03, RF06,
        RF07, RF08, RF09, RFAM, RG03, RG04, RG05, RG06, RH09, RH12,
        RH13, RJ40, RJC0, RJC5, RJC6, RJC7, RJC9, RJCA, RJCB, RJL3, RJL4,
        RJL5, RJL6, RJL7, RJL8, RJM1, RJM2, RJM3, RJS1, RJS2, RJT0, RJT2,
        RJT3, RJT7, RJT8, RJT9, RK1X, TA18, TA35, XXX3   / ;
```

INCLUDE File FORCEMOD.PAR for Model Scalars and Parameters

```
SCALARS

     MAXOSCOST  maximum operation and support cost     /999999999/

     WT1  priority weight of warfighting goal in OBJDEF /.6995/

     WT2  priority weight of mission area balance goal in OBJDEF /.01/

     WT3  priority weight of turbulence goal in OBJDEF /.0005/
     ;

PARAMETERS

     BUDGET(t)         budget in thousands of dollars
     /
     FY94          10000000
     FY95          10000000
     FY96          10000000
     FY97          10000000
     FY98          10000000
     FY99          11000000
     FY00          11000000
     FY01          11000000
     FY02          11000000
     FY03          11000000
     FY04          12000000
     FY05          12000000
     FY06          12000000
     FY07          12000000
     FY08          12000000
     /
```

```
        MINLEVEL(j)        minimum increment funding level
*                          minimum increment funding level for
*                          MDEP increment J across the time horizon
        /
        01          0.6
        02          0.8
        03          0.8
        04          0.8
        05          0.8
        06          0.8
        07          0.8
        08          0.8
        09          0.8
        10          0.8
        / ;

PARAMETER RAMP(i,j) ramp up funding factor for turbulence goal ;
*                          fraction of previous fiscal year's funding
*                          level aspired for current fiscal year

        RAMP(i,j) = 0.9 ;
```

INCLUDE File FORCEMOD.DAT for Share and MDEP Database

TABLE SHAREDATA(k,*) "minimum, desired and maximum funding share by TRADOC mission area"

	Minimum	Desired	Maximum
COM	.04	.08	.12
C2	.01	.03	.06
IEW	.03	.06	.09
EMW	.01	.03	.06
AD	.02	.04	.08
FS	.10	.16	.20
CSS	.10	.14	.20
AVN	.12	.20	.30
CCL	.05	.09	.15
CCH	.08	.13	.18
NBC	.02	.04	.07

;

TABLE MDEPDATA(i,j,k,*) input database for all MDEP increments

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
ACE3.01.COM		3.84	0	0	0	750	0	0
FA0A.01.C2		0.21	0	0	0	4500	0	0
FL6P.01.IEW		7.64	0	0	0	0	0	6600
FL6Q.01.EMW		1.34	0	0	0	2900	0	3600
FL6V.01.AD		2.84	0	0	0	0	9781	6788
FL6V.02.AD		0.12	0	0	0	0	0	0
FL6X.01.FS		3.52	0	0	0	0	0	0
FL6X.02.FS		0.44	0	0	0	0	0	26780
FL6Y.01.FS		2.57	0	0	0	0	0	0
FL8D.01.CSS		4.80	0	0	0	55320	20738	30234
FL8G.01.CSS		5.26	0	0	0	42306	60280	71565
FPAV.01.AVN		0.30	0	0	0	0	0	0
FPDA.01.FS		3.96	0	0	0	0	8994	12709
FPDA.02.FS		0.29	0	0	0	0	3500	4500
FPDB.01.IEW		7.64	0	0	0	122719	232653	220692
FPDB.04.IEW		4.25	0	0	0	0	0	0
FPDB.05.IEW		0.55	0	0	0	0	0	0
FPDB.06.IEW		0.09	0	0	0	0	0	0
FPDC.01.CCL		23.83	0	0	0	0	20155	38055
FPDC.06.CCL		0.52	0	0	0	0	0	0

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
FPDD.01.IEW		3.61	0	0	0	35200	48721	73671
FPDE.01.CCL		1.59	0	0	0	109729	163062	160754
FPDE.02.CCL		0.48	0	0	0	0	0	0
FPDF.01.IEW		0.09	0	0	0	0	0	0
FPDG.01.AD		4.54	0	0	0	0	40079	19358
FPDH.01.FS		10.27	0	0	0	10130	27469	31851
FPDH.04.FS		2.57	0	0	0	3839	0	0
FPDK.01.IEW		5.95	0	0	0	37951	119705	97467
FPDL.01.IEW		1.70	0	0	0	0	0	14003
FPDM.01.IEW		0.13	0	0	0	0	6299	408
FPDP.01.IEW		7.64	0	0	0	46526	82916	78593
FPDQ.01.AD		2.38	0	0	0	14674	32914	21522
FPDQ.02.AD		0.21	0	0	0	0	0	0
FPEA.01.AVN		3.03	0	0	0	138531	223500	208379
FPEA.02.AVN		0.45	0	0	0	0	0	0
FPED.01.AVN		3.80	0	0	0	0	25000	25000
FPED.02.AVN		3.03	0	0	0	143881	75166	99127
FPED.04.AVN		0.30	0	0	0	0	0	0
FPEE.01.AVN		5.16	0	0	0	11377	18393	19735
FPEE.02.AVN		0.45	0	0	0	10915	277	23404
FPEF.01.AVN		6.99	0	0	0	38670	201915	94869
FPEG.01.AVN	1	19.74	122440	169130	20194573	162531	537315	454075
FPEG.04.AVN		0.45	0	0	0	0	0	0
FPEH.01.AVN		6.38	0	141694	26387646	290909	256877	23952
FPEH.04.AVN		0.45	0	0	0	0	0	0
FPEL.01.AVN	1	4.86	0	185053	2541894	193045	242149	268890
FPEL.02.AVN		1.83	0	75400	0	0	0	0
FPEL.05.AVN	1	0.45	0	0	0	0	27000	88000
FPEM.01.AVN		6.07	0	2256	0	5537	3012	613
FPEN.01.AVN		6.07	0	0	8576922	3038	3445	3654
FPEN.04.AVN		0.30	0	5958	0	0	0	0
FPEP.01.AVN		6.38	0	43733	0	17706	18282	14113
FPEP.06.AVN		0.30	0	0	0	0	0	0
FPEQ.01.AVN		0.30	0	0	138842	0	0	0
FPFB.01.AD		4.54	0	50935	326591	0	31953	42311
FPFC.01.AD		0.57	0	0	0	0	0	0
FPFJ.01.C2		7.13	0	0	0	18074	23949	21344
FPFK.01.CSS		4.15	0	43859	200863	9078	17866	19159
FPFL.01.FS	1	13.94	0	3058443	0	40763	45890	45517
FPFM.01.FS		7.34	0	33193	5396984	10049	28180	33147
FPFM.05.FS		0.29	0	0	0	0	0	0
FPFP.01.C2		8.15	0	111427	1323900	22975	78826	76025
FPGA.01.AVN		48.50	109710	4142959	8973773	340423	549697	617246
FPGA.02.AVN		45.45	0	0	0	0	0	0
FPHB.01.FS		3.52	0	0	0	189708	132957	149718

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
FPHC.01.FS		6.17	0	0	0	104848	150816	108907
FPHD.01.CCL		1.62	0	0	0	0	2513	816
FPHE.01.CCH		10.09	0	0	0	79596	54679	39742
FPHE.02.CCH		1.62	0	0	0	0	0	0
FPHE.03.CCH		0.20	0	0	0	0	0	0
FPJA.01.CSS		9.69	0	83816	579644	280849	293490	347106
FPJA.02.CSS		0.37	0	127186	287307	0	0	0
FPJA.04.CSS		0.13	0	0	0	0	0	0
FPJB.01.CSS		6.56	0	114148	0	244256	275282	254871
FPJB.02.CSS		0.37	0	0	0	4860	9185	4710
FPJB.04.CSS		0.13	0	0	0	1363	3133	3131
FPJB.06.CSS		0.13	0	0	0	0	0	0
FPJC.01.CSS	1	1.62	0	238523	6678044	65104	180170	307244
FPJC.02.CSS		0.32	0	0	0	0	0	0
FPJC.04.CSS		0.13	0	0	0	3367	0	0
FPJC.06.CSS		0.13	0	0	0	0	3000	6000
FPLB.01.CCL		25.82	0	0	0	0	120406	123600
FPLC.01.FS		16.88	0	0	0	193075	174913	192415
FPLE.01.AVN		19.74	0	0	0	41049	37453	130992
FPLF.01.FS		11.73	0	0	0	479943	228514	226354
FPLF.04.FS		0.88	0	0	0	0	0	0
FPLF.06.FS		0.15	0	0	0	0	0	0
FPLG.01.FS		3.41	0	0	0	174033	66973	101166
FPLG.02.FS		0.15	0	0	0	0	0	0
FPLK.01.CCH		6.86	0	0	0	246504	297787	256968
FPLK.02.CCH		0.80	0	0	0	0	0	0
FPLK.04.CCH		0.20	0	0	0	0	0	0
FPLX.01.FS		6.16	0	0	0	26755	220713	200259
FPLZ.01.FS		3.26	0	0	0	0	0	20000
FPMA.01.C2		6.11	0	145327	401182	6305	32699	17115
FPMB.01.COM		2.39	0	2000	12027239	29257	72538	52880
FPMC.01.COM		9.21	0	126700	104115	77578	48775	69263
FPMC.05.COM		0.28	0	0	0	0	0	0
FPMD.01.COM		4.89	0	515255	0	22509	36733	52862
FPMH.01.COM		3.36	0	23232	303086	48354	73446	82869
FPMH.02.COM		0.58	0	591713	0	0	0	0
FPMH.03.COM		0.20	0	0	0	0	0	0
FPMJ.01.COM		8.64	0	192942	16602	20175	23442	21709
FPMJ.05.COM		0.20	0	0	0	0	0	0
FPMK.01.COM	1	8.15	0	250563	1687300	0	91093	77527
FPMK.04.COM		0.28	0	0	0	0	0	0
FPMK.06.COM		0.20	0	0	0	0	0	69000
FPMM.01.COM	1	10.55	0	294146	4286658	312025	290713	309528
FPMM.04.COM		0.20	0	0	0	0	0	0
FPNA.01.AD		1.36	0	463023	2497000	90850	97387	208802

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
FPNB.01.CCL		25.80	0	31200	0	72324	25122	30001
FPNC.01.AD	1	3.74	0	0	11278360	782690	178368	84436
FPNC.03.AD		0.12	0	0	0	0	0	0
FPNE.01.AD		2.84	0	0	693676	252188	40562	12113
FPNE.02.AD		0.49	0	2845	0	0	0	0
FPNE.05.AD		0.12	0	0	0	0	0	0
FPNF.01.AD		3.96	0	208255	316215	117571	190385	170100
FPNG.01.AD		0.17	0	0	0	0	0	0
FPNH.01.AD		4.54	0	0	0	0	12000	0
FPSA.01.CCH	1	9.69	0	123880	0	899186	161110	71868
FPSA.06.CCH	1	0.80	0	100540	0	0	0	0
FPSB.01.CCH	1	9.69	0	31852	0	752023	294598	145259
FPSB.04.CCH		0.20	0	0	0	0	0	0
FPSD.01.CCH		6.86	73800	202185	638279	52247	152255	141871
FPSD.04.CCH		0.29	0	6584	0	54460	16762	30109
FPSD.06.CCH		0.29	0	0	0	0	0	0
FPSE.01.CCH		15.64	176300	428000	1984300	17378	292925	212324
FPSE.02.CCH		4.44	0	0	0	0	0	0
FPSF.01.EMW		8.06	18200	100650	151900	0	9454	5518
FPSG.01.FS		11.01	46100	202840	494400	0	52784	100591
FPSH.01.FS		11.01	18400	110890	311300	0	0	0
FPSJ.01.CCH		1.62	66400	429990	665400	0	0	2273
FPSL.01.CCH		0.20	0	136201	132595	0	0	0
FPWB.01.IEW	1	8.50	0	153061	0	42099	179354	151399
FPWB.06.IEW		0.09	0	91986	0	0	0	0
FPWC.01.EMW		5.37	0	22895	0	10623	22387	22744
FPWC.04.EMW		0.11	0	0	0	0	0	0
FPWC.05.EMW		0.11	0	14766	0	0	0	0
FPWC.06.EMW		0.11	0	24633	0	0	0	0
FPWD.01.IEW		1.28	0	0	0	0	4491	7100
FPWD.04.IEW		0.55	0	0	0	0	0	0
FPXK.01.AD		0.68	0	0	0	69338	65000	69300
FPXK.02.AD		0.68	0	0	0	0	0	0
FPXX.01.CCH		0.80	0	0	0	1000	0	0
FPXX.06.CCH		0.20	0	0	0	0	0	0
FS01.01.FS		0.18	0	0	0	0	0	0
FTMD.01.AD		6.80	0	0	0	0	0	0
LARM.01.FS		0.15	0	0	0	0	0	0
LONG.01.FS		0.15	0	0	0	0	0	0
MPKA.01.C2		1.32	0	44220	853948	37461	24308	19417
MPTK.01.CSS		5.82	0	5100	0	9655	14886	15875
MPTL.01.CSS		1.71	0	1500	0	8336	7062	4573
MPTM.01.CSS		2.40	0	200	0	0	25703	3959
MS2B.01.COM		7.67	0	0	0	523	700	1440
MS5S.01.CSS		1.76	0	0	0	0	0	0
MT1A.01.COM		0.20	0	9320	0	0	0	0

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
MT1D.01.C2		0.21	0	0	0	0	0	0
MT1G.01.CSS		5.17	0	79724	0	28092	33252	31936
MT1L.01.C2		5.09	0	0	0	16923	47755	42280
MT5Y.01.COM		7.67	0	0	0	0	8785	8790
MX5T.01.COM		8.83	0	33762	0	39489	49543	82265
NEW.01.COM		0.20	0	665000	0	0	0	0
PEWE.01.AVN		6.39	0	1183	0	0	1328	1225
RA02.01.CSS		5.91	0	0	0	6625	11052	11416
RA08.01.CCH		3.23	0	19120	28124090	0	0	0
RA08.06.CCH		0.16	0	79029	0	0	0	0
RA09.01.CCH		3.23	0	0	0	0	0	0
RA09.02.CCH		0.20	0	0	0	0	5700	5927
RA11.01.CCL		4.17	0	0	0	42194	41902	32971
RA11.04.CCL		0.48	0	0	0	0	0	0
RA11.06.CCL		0.39	0	0	0	0	17000	0
RA14.01.CCL		1.59	0	0	0	16430	27197	16675
RA18.01.CCH		15.24	0	14561808	1228957	4937	37893	32268
RA31.01.CCH		0.29	0	0	0	0	0	0
RA31.06.CCH		0.20	0	0	0	0	0	0
RB03.01.FS		8.36	0	0	0	0	22088	22180
RB04.01.FS		8.36	0	4633	0	26235	36420	36642
RB07.01.FS		3.38	0	0	0	12483	14993	16982
RB08.01.FS		0.15	0	0	0	24597	0	0
RB12.01.FS		7.34	0	0	0	0	2048	2800
RB14.01.FS		7.49	0	0	0	0	1002	5337
RB16.01.FS		0.15	0	0	0	0	0	0
RB21.01.FS		8.08	0	0	0	450	451	301
RB25.01.FS		1.10	0	0	0	0	0	0
RC01.01.AD		2.55	0	0	0	23509	18379	8259
RC01.02.AD		0.12	0	0	0	0	0	0
RC02.01.AD		2.45	0	41985	4076203	56598	25265	1304
RC04.01.AD		0.12	0	0	0	0	0	0
RD06.01.AVN		0.30	0	0	0	0	0	0
RD07.01.AVN		5.91	0	0	3612664	7805	21934	3800
RD07.04.AVN		0.45	0	0	0	0	0	0
RD12.01.AVN		5.00	0	0	15254067	10220	9166	3300
RD12.02.AVN		0.30	0	0	0	0	0	0
RD13.01.AVN		0.30	0	0	1989718	0	0	0
RD15.01.AVN		6.68	0	0	0	27696	30737	28722
RD16.01.AVN		7.29	0	0	0	28048	24697	22931
RD17.01.AVN		5.01	0	0	0	7055	6349	6903
RD18.01.AVN		4.85	0	0	0	14082	2905	11736
RD19.01.AVN		1.53	0	0	0	0	0	0
RD22.01.AVN		0.45	0	0	0	0	0	0
RE02.01.CSS		0.37	0	0	0	0	0	0

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
RF01.01.EMW		1.61	0	0	0	5037	4514	9032
RF02.01.EMW		8.06	0	15861	0	2905	24094	31322
RF02.02.EMW		0.11	0	0	0	4620	11431	10024
RF03.01.EMW		1.98	0	0	0	0	0	0
RF03.04.EMW		0.11	0	0	0	0	0	0
RF03.06.EMW		0.11	0	0	0	0	0	0
RF06.01.EMW		0.16	0	0	0	0	0	0
RF07.01.EMW		1.34	0	0	0	0	1900	3451
RF08.01.EMW		1.67	0	0	0	0	9425	24074
RF09.01.EMW		1.88	0	0	0	33860	59527	62665
RF09.06.EMW		0.16	0	0	0	0	0	0
RFAM.01.FS		0.29	0	0	0	0	0	0
RG03.01.NBC		8.02	0	0	0	43070	68151	78337
RG04.01.NBC		8.02	0	0	0	144228	129029	77250
RG05.01.NBC		8.02	0	512	0	25852	13718	6966
RG06.01.NBC		8.02	0	10175	0	18610	19267	28229
RG06.02.NBC		0.65	0	0	0	0	0	2700
RG06.03.NBC		0.65	0	0	0	0	11700	13900
RH09.01.C2		1.22	0	0	0	3207	3827	3034
RH12.01.IEW		1.34	0	4500	0	0	15721	16243
RH12.04.IEW		0.13	0	6300	0	0	0	0
RH13.01.IEW		1.53	0	0	0	1506	1191	1281
RH13.04.IEW		0.09	0	0	0	0	0	0
RJ40.01.CSS		1.66	0	2536	335677	0	0	0
RJC0.01.CSS		6.47	0	0	0	0	5100	3500
RJC5.01.CSS		1.71	0	0	0	2261	2859	2116
RJC6.01.CSS		1.85	0	0	0	6837	14981	14885
RJC7.01.CSS		5.51	0	5184	0	1752	10714	19668
RJC9.01.CSS		6.47	0	10175	0	46234	79586	58168
RJCA.01.CSS		1.89	0	0	0	1600	1504	1483
RJCB.01.CSS		1.46	0	0	0	0	3200	5692
RJL3.01.CSS		2.27	0	0	0	4999	6600	0
RJL4.01.CSS		2.03	0	69362	0	8135	18101	34591
RJL4.02.CSS		1.16	0	0	0	0	0	0
RJL5.01.CSS		1.85	0	0	0	32856	7944	5090
RJL6.01.CSS		2.27	0	0	0	8016	9879	3478
RJL7.01.CSS		6.47	0	0	0	12477	21927	13753
RJL8.01.CSS		5.26	0	9421	0	20597	34999	26861
RJM1.01.CSS		0.92	0	7714	0	71806	85079	71642
RJM2.01.CSS		6.47	0	0	0	94444	58026	55251
RJM3.01.CSS		2.12	0	0	0	622	789	283
RJS1.01.CSS		8.31	0	0	0	29585	30491	29518
RJS2.01.CSS		3.23	0	0	0	9569	37148	15418
RJS2.05.CSS		0.41	0	34800	0	0	0	0
RJT0.01.CSS		1.47	0	0	0	7522	16900	14097
RJT2.01.CSS		2.31	0	0	0	0	2492	0

	MAND	VALUE	CAT_3	CAT_4	CAT_5	FY91	FY92	FY93
RJT3.01.CSS		1.71	0	1480	370360	0	0	0
RJT7.01.CSS		2.31	0	29183	0	19438	997	683
RJT8.01.EMW		0.11	0	0	0	0	0	0
RJT9.01.CSS		1.42	0	0	0	0	3103	2106
RK1X.03.FS		0.18	0	0	0	0	0	600
TA18.01.IEW		1.44	0	0	0	0	1366	2071
TA18.04.IEW		0.13	0	0	0	0	0	0
TA35.01.IEW		1.44	0	0	0	211	800	0
TA35.04.IEW		0.13	0	0	0	0	0	0
XXX3.01.CCL		3.97	0	0	0	0	0	0

TABLE MDEPDATA(i,j,k,) (continued for FY94-02)*

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
ACE3.01.COM	0	0	0	0	0	0	0	0	0
FA0A.01.C2	3000	3000	3000	3000	3000	3000	3000	3000	3000
FL6P.01.IEW	14112	18162	44172	59665	51256	62567	64274	64407	64585
FL6Q.01.EMW	5800	6000	9300	3000	0	0	0	0	0
FL6V.01.AD	0	0	0	0	0	0	0	0	0
FL6V.02.AD	20	20	38	0	0	0	0	0	0
FL6X.01.FS	98700	0	0	0	0	0	0	0	0
FL6X.02.FS	48500	31800	15600	15600	0	0	0	0	0
FL6Y.01.FS	9400	20100	85200	85700	85700	0	0	0	0
FL8D.01.CSS	25131	25137	24207	24656	25121	25601	26097	26610	27142
FL8G.01.CSS	110807	101443	131393	134666	125103	126319	126025	93779	91642
FPAV.01.AVN	0	0	50000	100000	150000	126000	220000	220000	262800
FPDA.01.FS	15048	13781	12785	4566	0	0	0	0	0
FPDA.02.FS	8400	11500	21800	18906	22000	40500	35300	23500	3000
FPDB.01.IEW	176721	92535	50406	41282	38837	18437	19037	19637	0
FPDB.04.IEW	0	0	43300	41400	49800	1600	0	0	0
FPDB.05.IEW	0	0	26200	22900	22600	3600	3200	0	0
FPDB.06.IEW	0	0	0	0	0	26800	104700	164500	172600
FPDC.01.CCL	31915	59092	51210	8101	1169	0	0	0	0
FPDC.06.CCL	0	0	0	52400	59921	54454	8703	1700	0
FPDD.01.IEW	84626	84971	103700	124000	121000	44600	43200	91000	83300
FPDE.01.CCL	162173	169936	166394	161783	138364	136064	135264	137764	137764
FPDE.02.CCL	0	0	36400	141860	223460	223460	223460	320660	304350
FPDF.01.IEW	1000	4000	6100	7830	8190	7600	8120	7460	6430
FPDG.01.AD	60303	106856	99999	113602	0	0	0	0	0
FPDH.01.FS	35791	32936	31659	13010	0	0	0	0	0
FPDH.04.FS	7941	8665	63400	60100	76300	55300	57000	6200	3700
FPDK.01.IEW	107166	26142	71399	41750	17067	10751	8500	2500	2500
FPDL.01.IEW	71286	104559	95928	73809	81875	81425	36524	3859	1183
FPDM.01.IEW	512	45933	68855	69705	71797	71939	27447	3467	1798

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
FPDP.01.IEW	112915	118272	96382	64400	70074	93380	100100	93180	87800
FPDQ.01.AD	11527	0	0	0	0	0	0	0	0
FPDQ.02.AD	58331	50926	77884	101940	106934	109421	59176	48507	13226
FPEA.01.AVN	200206	155238	105300	13643	25000	5000	25000	5000	25000
FPEA.02.AVN	48000	45000	26000	10000	0	0	0	0	0
FPED.01.AVN	25000	25000	25000	25000	25000	25000	25000	25000	25000
FPED.02.AVN	91052	93428	80427	93777	13273	11467	-8675	-8675	-8675
FPED.04.AVN	0	0	0	0	0	0	46521	55071	55071
FPEE.01.AVN	24520	21379	15864	17686	21300	21100	10800	10800	10800
FPEE.02.AVN	27252	20473	23599	14711	8500	25000	25000	25000	700
FPEF.01.AVN	154462	120989	14161	5589	0	0	0	0	0
FPEG.01.AVN	473176	462179	400173	27077	29200	21900	5000	5000	5000
FPEG.04.AVN	100	300	23300	300	32100	400	17600	400	20400
FPEH.01.AVN	22077	7300	7200	8400	6600	6300	6600	6400	6500
FPEH.04.AVN	100	300	200	3500	9100	8100	10800	5200	5400
FPEL.01.AVN	0	0	0	0	0	0	0	0	0
FPEL.02.AVN	351785	458120	404398	411163	645605	704556	686120	429012	304700
FPEL.05.AVN	110000	155000	223000	257500	253800	287900	232900	183300	25000
FPEM.01.AVN	718	925	0	0	0	0	0	0	0
FPEN.01.AVN	0	0	0	0	0	0	0	0	0
FPEN.04.AVN	13199	16775	11108	12914	4000	2800	2500	2100	2000
FPEP.01.AVN	9014	7474	48602	46819	32839	23833	20948	21176	18132
FPEP.06.AVN	0	0	14451	14300	14300	0	0	0	0
FPEQ.01.AVN	140800	274500	41380	85000	87990	109380	111860	114020	85240
FPFB.01.AD	61200	68980	61400	57600	33900	31300	30200	31500	28000
FPFC.01.AD	0	0	29355	9507	0	0	0	0	0
FPFJ.01.C2	22082	20568	21000	21200	21600	22700	23800	21900	13000
FPFK.01.CSS	31024	39932	41796	40100	31800	29500	27400	26100	19600
FPFL.01.FS	93120	113111	98400	94600	59500	67600	66400	63700	47400
FPFM.01.FS	42126	39285	2539	2233	0	0	0	0	0
FPFM.05.FS	0	0	18278	18228	18819	11044	0	0	0
FPFP.01.C2	71465	89697	76940	75160	72143	76351	48782	19068	18234
FPGA.01.AVN	620848	751815	1153573	2084738	2018200	2506200	3060600	3164600	3065000
FPGA.02.AVN	0	0	0	0	0	38100	68900	192100	203800
FPHB.01.FS	193900	237195	181684	4464	3308	0	0	0	0
FPHC.01.FS	223969	179992	226791	202000	235800	324100	337800	350100	364700
FPHD.01.CCL	1068	0	0	0	0	0	0	0	0
FPHE.01.CCH	43448	9886	40000	40000	40000	40000	0	0	0
FPHE.02.CCH	65700	69300	73191	64500	57000	59400	0	0	0
FPHE.03.CCH	0	0	0	13700	28100	37500	0	0	0
FPJA.01.CSS	343481	367266	142060	82708	65972	8478	13145	1518	1570
FPJA.02.CSS	0	0	0	0	0	0	0	196183	202256
FPJA.04.CSS	0	0	1404	1452	1502	1553	1606	1660	1716
FPJB.01.CSS	211281	91739	69797	68961	49055	42376	43164	42595	41565
FPJB.02.CSS	8290	10983	15035	15302	180000	185400	190962	196690	13421
FPJB.04.CSS	3128	4950	3354	12949	1502	1553	1606	1660	1716

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
FPJB.06.CSS	0	0	208100	353692	14267	6858	0	0	0
FPJC.01.CSS	411307	426665	479512	577502	577331	577432	576648	577734	576097
FPJC.02.CSS	0	0	0	0	147000	222000	222000	302000	329000
FPJC.04.CSS	0	0	1404	1452	1502	1553	1606	1660	1716
FPJC.06.CSS	13645	20387	19314	18164	34402	105166	108742	112437	116266
FPLB.01.CCL	341518	454054	438310	400312	404975	413081	346837	3555	3573
FPLC.01.FS	233955	193500	156700	93200	20000	0	0	0	0
FPLE.01.AVN	134305	45456	0	0	0	0	0	0	0
FPLF.01.FS	343937	319529	276332	262406	309709	318341	327267	321867	275261
FPLF.04.FS	13934	32416	35517	17203	43189	112155	0	0	0
FPLF.06.FS	58300	135300	195300	237600	244000	216000	221800	227900	242300
FPLG.01.FS	107200	83900	53700	36700	32000	0	0	0	0
FPLG.02.FS	0	18400	89800	105100	155500	224700	299900	350000	350000
FPLK.01.CCH	116878	73005	68600	78600	101700	93700	88400	69500	10600
FPLK.02.CCH	0	0	12100	63300	105800	277000	260000	253700	257300
FPLK.04.CCH	40000	198264	239400	248200	263400	251700	41700	25000	16800
FPLX.01.FS	366486	596290	557327	499258	429200	430600	412600	425200	419500
FPLZ.01.FS	20000	100100	130768	243700	255000	160900	186600	190400	194700
FPMA.01.C2	29536	32471	62678	66671	67835	68029	68271	55240	55240
FPMB.01.COM	44217	42945	68600	32700	0	0	0	0	0
FPMC.01.COM	42146	42330	115702	114873	106667	104125	72104	48225	17500
FPMC.05.COM	75100	68600	0	0	0	0	0	0	0
FPMD.01.COM	120591	155396	167449	183322	211890	215541	211891	209865	234794
FPMH.01.COM	0	0	0	0	0	0	0	0	0
FPMH.02.COM	63173	79688	107879	137542	147451	155503	149950	155230	162867
FPMH.03.COM	33575	23796	34116	44792	47236	52776	56252	58165	60142
FPMJ.01.COM	31402	27420	33192	34455	68868	65606	182324	159698	151109
FPMJ.05.COM	0	0	17603	14278	28723	18575	10765	11300	12012
FPMK.01.COM	85089	80964	128544	87391	70987	54698	54731	55680	42431
FPMK.04.COM	0	0	32000	50000	50000	50000	20000	20000	10000
FPMK.06.COM	215800	101392	106673	62728	15960	0	0	0	0
FPMM.01.COM	417917	558892	452818	239065	44278	8868	9094	7332	13628
FPMM.04.COM	0	0	364500	198100	350700	419300	0	0	0
FPNA.01.AD	482749	427669	464000	453400	508900	502500	504600	500700	510800
FPNB.01.CCL	92077	123039	154087	141058	154100	163500	174400	174700	113600
FPNC.01.AD	65942	58901	45492	45641	31200	24300	40900	33800	33800
FPNC.03.AD	0	0	0	0	0	0	0	15000	35000
FPNE.01.AD	0	0	0	0	0	0	0	0	0
FPNE.02.AD	59448	58759	63269	5846	4700	4700	4700	4700	4700
FPNE.05.AD	104500	107700	111100	114600	118300	117000	11400	7500	0
FPNF.01.AD	146540	225605	241774	258469	158920	39080	25290	0	0
FPNG.01.AD	7220	4737	24500	39800	74700	78000	82800	82800	10800
FPNH.01.AD	3700	0	0	0	0	0	0	0	0
FPSA.01.CCH	232630	151142	90880	86402	57624	42712	42712	42712	0
FPSA.06.CCH	161293	743495	845908	875830	869548	965868	782987	637994	147215

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
FPSB.01.CCH	185866	52060	71530	56050	0	0	0	0	0
FPSB.04.CCH	0	0	107700	83900	62000	126400	126400	126400	126400
FPSD.01.CCH	274353	253900	169200	486779	475976	495124	451323	370836	375205
FPSD.04.CCH	35899	95000	110980	197364	202986	137081	112893	100768	101506
FPSD.06.CCH	0	0	0	13	13675	154425	291120	282805	354525
FPSE.01.CCH	192465	129832	131625	78600	55400	38700	11000	10000	10000
FPSE.02.CCH	0	0	0	421203	791800	543600	472260	322590	1351260
FPSF.01.EMW	7484	51900	34475	30685	153792	218530	185860	161990	280970
FPSG.01.FS	104009	137711	104252	41500	286436	390972	370240	299846	523160
FPSH.01.FS	11707	21327	18403	11401	59107	90256	80742	89703	252219
FPSJ.01.CCH	55502	70704	59367	45158	241740	369200	414530	413690	649070
FPSL.01.CCH	0	3300	3400	16820	253730	359950	362450	493950	284500
FPWB.01.IEW	143195	108793	76187	64387	193158	211852	193308	190259	128290
FPWB.06.IEW	0	0	0	0	7874	0	0	0	84768
FPWC.01.EMW	28410	37794	38435	30075	13898	13788	15242	1069	1079
FPWC.04.EMW	0	0	1096	967	2554	2942	1013	1319	1500
FPWC.05.EMW	0	0	20111	22435	7855	5805	17625	0	0
FPWC.06.EMW	0	0	0	10313	6563	1573	1448	16449	16305
FPWD.01.IEW	0	0	0	0	0	0	0	0	0
FPWD.04.IEW	7800	6000	4500	5100	14200	6783	0	0	0
FPXK.01.AD	0	0	0	0	0	0	0	0	0
FPXK.02.AD	74000	71720	103064	139146	166760	153961	0	0	0
FPXX.01.CCH	24600	28700	63300	159000	125600	120800	195250	195450	195650
FPXX.06.CCH	24600	13533	0	0	0	0	0	0	0
FS01.01.FS	0	0	0	0	16000	15000	15000	15000	15000
FTMD.01.AD	0	0	0	0	0	0	0	0	0
LARM.01.FS	0	0	0	0	0	0	23600	27900	31200
LONG.01.FS	2100	3600	2700	12200	23700	18900	85320	189600	189600
MPKA.01.C2	17582	19642	29624	31456	32678	34262	24813	18085	18834
MPTK.01.CSS	17619	5120	7507	3000	9750	9750	7500	9000	12000
MPTL.01.CSS	5100	5100	9564	9564	9564	9564	7164	7164	7164
MPTM.01.CSS	1787	161	18100	18800	23600	22400	23500	25300	22500
MS2B.01.COM	1907	3817	4312	4308	5000	6000	7000	8000	9000
MS5S.01.CSS	1900	1900	2000	1500	529	0	0	0	0
MT1A.01.COM	0	0	0	0	18080	22002	4240	35	0
MT1D.01.C2	8000	8000	8000	8000	8000	8000	8000	8000	8000
MT1G.01.CSS	34955	39206	38359	38874	37800	38100	38300	38700	38900
MT1L.01.C2	80503	74458	117100	92600	58200	50900	53600	11000	11100
MT5Y.01.COM	8014	8504	8680	7283	7494	7714	8000	8300	8615
MX5T.01.COM	104144	68909	78867	76228	73000	42100	42100	41450	41300
NEW.01.COM	0	0	10000	20000	70000	100000	150000	150000	665000
PEWE.01.AVN	20820	20363	20000	20000	20000	20000	20000	20000	20000
RA02.01.CSS	11853	8939	10924	19009	17039	20491	0	0	0
RA08.01.CCH	76039	78991	76001	8046	8368	8703	0	0	0
RA08.06.CCH	0	0	0	78576	81241	102973	106477	110096	113846
RA09.01.CCH	19600	20200	20900	21600	22400	23100	0	0	0

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
RA09.02.CCH	3227	3397	2240	2483	0	0	0	0	0
RA11.01.CCL	37648	17667	28078	33970	16000	5000	0	0	0
RA11.04.CCL	0	0	0	0	0	14985	54878	104029	123210
RA11.06.CCL	28000	0	0	0	0	0	0	0	0
RA14.01.CCL	21500	22339	9252	359	0	0	0	0	0
RA18.01.CCH	39507	105049	105092	186765	352586	183023	2712	0	0
RA31.01.CCH	0	0	82729	111517	214844	82307	88056	91035	75833
RA31.06.CCH	48100	81514	0	0	0	0	0	0	0
RB03.01.FS	0	0	0	0	0	0	0	0	0
RB04.01.FS	37809	28091	1042	880	0	0	0	0	0
RB07.01.FS	14162	14584	15483	14211	0	0	0	0	0
RB08.01.FS	0	0	0	0	0	0	0	0	0
RB12.01.FS	5550	5550	5300	5300	5300	2900	0	0	0
RB14.01.FS	5116	0	0	0	0	0	0	0	0
RB16.01.FS	0	0	0	10000	10000	10000	10000	0	0
RB21.01.FS	302	303	304	305	306	307	308	309	310
RB25.01.FS	0	0	33000	45000	40000	20000	40000	65000	64000
RC01.01.AD	0	0	0	0	0	0	0	0	0
RC01.02.AD	5555	4611	0	0	0	0	0	0	0
RC02.01.AD	30735	33305	20849	3421	7662	1500	1000	0	0
RC04.01.AD	0	0	0	0	0	0	33500	55400	178700
RD06.01.AVN	0	0	0	0	190000	350000	410000	520000	760000
RD07.01.AVN	3800	3800	3800	3800	3800	3800	3800	3800	3800
RD07.04.AVN	23307	18672	37000	28000	13000	16000	10000	10000	8000
RD12.01.AVN	3300	3300	3300	3300	3300	3300	3300	3300	3300
RD12.02.AVN	2566	1100	11200	14000	4200	4400	0	0	0
RD13.01.AVN	781	5397	20952	44243	43106	42009	43437	44916	46443
RD15.01.AVN	14500	10100	10105	10309	11499	12000	12170	12675	12780
RD16.01.AVN	13025	12343	12000	12000	12000	12000	12000	12000	12000
RD17.01.AVN	6908	7493	7386	7415	8191	8279	8356	8439	8523
RD18.01.AVN	18012	8581	8500	8532	8900	98000	200000	92000	6000
RD19.01.AVN	0	0	0	0	0	0	3800	7000	20000
RD22.01.AVN	0	0	0	0	0	9200	19400	8600	0
RE02.01.CSS	0	0	147100	0	0	0	0	0	0
RF01.01.EMW	7737	4650	18116	19300	19800	20400	19450	22710	18430
RF02.01.EMW	39794	37078	39169	51667	65200	51800	65000	54400	38100
RF02.02.EMW	9996	19973	19973	19973	19973	19973	19973	19973	0
RF03.01.EMW	9000	9000	9000	9000	9000	9000	9000	9000	9000
RF03.04.EMW	15300	7800	0	0	0	0	0	0	0
RF03.06.EMW	0	0	31600	17900	48200	35900	40800	40800	33100
RF06.01.EMW	0	3058	5700	8000	11300	9000	10200	7800	10600
RF07.01.EMW	3000	2650	4554	7558	8248	7015	5365	5625	2005
RF08.01.EMW	27966	37985	131000	178259	199121	26032	7885	0	0
RF09.01.EMW	63624	67189	36213	24600	5500	3700	0	0	0

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
RF09.06.EMW	29100	26400	37100	31000	0	0	0	31400	32600
RFAM.01.FS	0	0	0	0	0	3200	22700	36800	26100
RG03.01.NBC	76244	44905	50792	33796	24600	26800	29000	34000	36000
RG04.01.NBC	129133	144207	149772	141670	147720	158200	144476	168100	102500
RG05.01.NBC	23614	15476	20651	17207	20682	20700	19000	24600	27000
RG06.01.NBC	50445	41087	67609	72044	18500	23300	39200	36500	32200
RG06.02.NBC	1610	0	0	0	0	0	0	0	0
RG06.03.NBC	22000	18600	33600	34400	0	0	0	0	0
RH09.01.C2	6825	6300	6005	5990	6004	6004	6003	6004	6008
RH12.01.IEW	14089	5323	7577	8800	6000	6700	0	0	0
RH12.04.IEW	0	0	0	0	0	0	7300	7600	7800
RH13.01.IEW	1276	0	0	0	0	0	0	0	0
RH13.04.IEW	0	0	2799	1840	2683	2004	1979	2799	1848
RJ40.01.CSS	0	0	2980	12900	37300	48000	48000	48000	24800
RJC0.01.CSS	4200	2200	41022	35404	9404	3996	4132	4272	4417
RJC5.01.CSS	3289	4870	20218	20927	29369	29006	16880	17166	8961
RJC6.01.CSS	16143	10096	88587	30070	33300	27700	28400	26900	26900
RJC7.01.CSS	22223	5221	31490	59782	59677	54948	67256	75440	76211
RJC9.01.CSS	71060	65360	70583	68482	56717	60262	67509	68171	69514
RJCA.01.CSS	1476	1448	77000	86800	89000	87800	87350	77200	28200
RJCB.01.CSS	6488	5215	3420	3480	3960	2400	0	0	0
RJL3.01.CSS	0	0	0	0	0	0	0	0	0
RJL4.01.CSS	26427	17876	49036	57380	8850	11600	11000	11000	11000
RJL4.02.CSS	3500	4500	40500	45000	45000	45000	49500	0	0
RJL5.01.CSS	4961	4909	3576	3828	3828	2500	2500	2500	2500
RJL6.01.CSS	3984	4000	0	0	0	0	0	0	0
RJL7.01.CSS	18311	16180	25135	34038	23100	25100	30100	26750	27000
RJL8.01.CSS	23982	18332	22959	39417	26708	24375	21425	18625	18900
RJM1.01.CSS	101634	118539	138172	142274	100400	100900	131500	125600	130000
RJM2.01.CSS	57167	50168	41290	42006	44363	44001	44687	46171	47047
RJM3.01.CSS	285	270	0	0	0	0	0	0	0
RJS1.01.CSS	39296	36845	51914	30785	40889	60253	154466	161987	164353
RJS2.01.CSS	1183	1214	13458	13659	3460	4510	4459	5304	5300
RJS2.05.CSS	62000	8800	34000	23750	22375	22115	17275	10525	6125
RJT0.01.CSS	8200	11700	10000	10000	0	0	0	0	0
RJT2.01.CSS	0	0	0	0	0	0	0	0	0
RJT3.01.CSS	300	500	20915	20915	20915	3490	0	0	0
RJT7.01.CSS	1483	4090	4920	4710	1660	1710	1770	1830	1890
RJT8.01.EMW	0	0	16100	13480	13050	11900	11500	9800	12000
RJT9.01.CSS	3107	4100	5100	6100	8170	5139	6535	6535	6535
RK1X.03.FS	900	700	5000	0	0	0	2700	5400	5600
TA18.01.IEW	3253	0	0	0	0	0	0	0	0
TA18.04.IEW	0	0	3253	3253	3253	3253	3253	3253	3253
TA35.01.IEW	0	0	0	0	0	0	0	0	0
TA35.04.IEW	0	0	3520	1521	1521	1521	1521	1521	1521

	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02
XXX3.01.CCL	6000	6300	6600	6900	7200	7500	0	0	0

TABLE MDEPDATA(i,j,k,) (continued for FY03-08)*

	FY03	FY04	FY05	FY06	FY07	FY08
ACE3.01.COM	0	0	0	0	0	0
FA0A.01.C2	3000	3000	3000	3000	3000	3000
FL6P.01.IEW	64067	63592	52028	47755	43497	38257
FL6Q.01.EMW	0	0	0	0	0	0
FL6V.01.AD	0	0	0	0	0	0
FL6V.02.AD	0	0	0	0	0	0
FL6X.01.FS	0	0	0	0	0	0
FL6X.02.FS	0	0	0	0	0	0
FL6Y.01.FS	0	0	0	0	0	0
FL8D.01.CSS	27690	28258	28844	29451	30078	30727
FL8G.01.CSS	90796	90815	87779	54712	55338	51370
FPAV.01.AVN	272800	276000	379000	518000	518100	468000
FPDA.01.FS	0	0	0	0	0	0
FPDA.02.FS	3000	3000	3000	0	0	0
FPDB.01.IEW	0	0	0	0	0	0
FPDB.04.IEW	0	0	0	0	0	0
FPDB.05.IEW	0	0	0	0	0	0
FPDB.06.IEW	482200	606600	239000	19900	20500	0
FPDC.01.CCL	0	0	0	0	0	0
FPDC.06.CCL	0	0	0	0	0	0
FPDD.01.IEW	86100	89000	105700	111000	114800	12500
FPDE.01.CCL	137764	118524	90444	87600	87600	87600
FPDE.02.CCL	284260	328360	232760	226380	222900	222900
FPDF.01.IEW	400	360	0	0	0	0
FPDG.01.AD	0	0	0	0	0	0
FPDH.01.FS	0	0	0	0	0	0
FPDH.04.FS	200	0	0	0	0	0
FPDK.01.IEW	2500	2500	2500	2500	2500	2500
FPDL.01.IEW	0	0	0	0	0	0
FPDM.01.IEW	0	0	0	0	0	0
FPDP.01.IEW	93200	104280	69087	71367	50857	51287
FPDQ.01.AD	0	0	0	0	0	0
FPDQ.02.AD	7517	16818	120	0	0	0
FPEA.01.AVN	5000	25000	5000	5000	5000	5000
FPEA.02.AVN	0	0	0	0	0	0
FPED.01.AVN	25000	25000	25000	25000	25000	25000
FPED.02.AVN	-8675	-8675	-8675	-8675	-8675	-8675
FPED.04.AVN	55071	55071	55071	55071	55071	55071
FPEE.01.AVN	6700	6800	6800	6800	6800	6800
FPEE.02.AVN	700	25700	25700	25700	25700	25700

	FY03	FY04	FY05	FY06	FY07	FY08
FPEF.01.AVN	0	0	0	0	0	0
FPEG.01.AVN	5000	5000	5000	5000	5000	5000
FPEG.04.AVN	400	23400	400	400	400	400
FPEH.01.AVN	6400	6500	6400	6400	6400	6400
FPEH.04.AVN	5400	5600	5600	5700	5800	5900
FPEL.01.AVN	0	0	0	0	0	0
FPEL.02.AVN	317700	326900	273733	0	0	0
FPEL.05.AVN	0	0	0	0	0	0
FPEM.01.AVN	0	0	0	0	0	0
FPEN.01.AVN	0	0	0	0	0	0
FPEN.04.AVN	1900	1500	1400	1400	1400	1400
FPEP.01.AVN	17871	17550	10458	3800	3850	4050
FPEP.06.AVN	0	0	0	0	0	0
FPEQ.01.AVN	53080	54160	55300	56530	57830	59200
FPFB.01.AD	0	0	0	0	0	0
FPFC.01.AD	0	0	0	0	0	0
FPFJ.01.C2	22200	23300	24500	22700	22900	23900
FPFK.01.CSS	500	0	0	0	0	0
FPFL.01.FS	1900	0	0	0	0	0
FPFM.01.FS	0	0	0	0	0	0
FPFM.05.FS	0	0	0	0	0	0
FPFP.01.C2	2586	0	0	0	0	474
FPGA.01.AVN	2944300	2912200	2953100	2763800	2769100	2613100
FPGA.02.AVN	211800	220100	229700	237700	246900	256600
FPHB.01.FS	0	0	0	0	0	0
FPHC.01.FS	464300	453800	470700	0	0	0
FPHD.01.CCL	0	0	0	0	0	0
FPHE.01.CCH	0	0	0	0	0	0
FPHE.02.CCH	0	0	0	0	0	0
FPHE.03.CCH	0	0	0	0	0	0
FPJA.01.CSS	1623	1679	1736	1795	1856	1919
FPJA.02.CSS	212600	219029	225654	232477	239510	246754
FPJA.04.CSS	1775	1835	1898	1962	2029	2099
FPJB.01.CSS	15371	1881	1944	12011	2079	2149
FPJB.02.CSS	13421	0	0	0	0	0
FPJB.04.CSS	1775	1835	1898	1962	2029	2099
FPJB.06.CSS	0	0	0	0	0	0
FPJC.01.CSS	613147	577079	576882	577295	577277	576942
FPJC.02.CSS	249000	313000	332000	344000	368000	404000
FPJC.04.CSS	1775	1835	1898	1962	2029	2099
FPJC.06.CSS	0	0	0	0	0	0
FPLB.01.CCL	0	0	0	0	0	0
FPLC.01.FS	0	0	0	0	0	0
FPLE.01.AVN	0	0	0	0	0	0
FPLF.01.FS	284588	293328	303309	313611	324285	335313
FPLF.04.FS	0	0	0	0	0	0

	FY03	FY04	FY05	FY06	FY07	FY08
FPLF.06.FS	0	0	0	0	0	0
FPLG.01.FS	0	0	0	0	0	0
FPLG.02.FS	302700	0	0	0	0	0
FPLK.01.CCH	0	0	0	0	0	0
FPLK.02.CCH	24300	0	0	0	0	0
FPLK.04.CCH	7900	2200	2300	2400	1000	1000
FPLX.01.FS	307100	0	0	0	0	0
FPLZ.01.FS	199700	203800	208700	209000	211000	213000
FPMA.01.C2	55240	69072	0	0	0	0
FPMB.01.COM	0	0	0	0	0	0
FPMC.01.COM	16000	16000	16000	16000	0	0
FPMC.05.COM	0	0	0	0	0	0
FPMD.01.COM	239058	97523	0	0	0	0
FPMH.01.COM	0	0	0	0	0	0
FPMH.02.COM	164340	167479	171371	182855	187548	189943
FPMH.03.COM	62187	64300	66490	68747	71085	73503
FPMJ.01.COM	139007	129258	123217	122793	123085	120898
FPMJ.05.COM	12589	13811	5179	0	0	0
FPMK.01.COM	1257	1000	1000	1000	1000	1000
FPMK.04.COM	0	0	0	0	0	0
FPMK.06.COM	0	0	0	0	0	0
FPMM.01.COM	26293	43058	49889	58895	74777	43718
FPMM.04.COM	0	0	0	0	0	0
FPNA.01.AD	521200	329500	36900	13200	0	0
FPNB.01.CCL	6600	3300	0	0	0	0
FPNC.01.AD	33800	33800	20000	20000	20000	20000
FPNC.03.AD	50000	70000	350000	575000	300000	400000
FPNE.01.AD	0	0	0	0	0	0
FPNE.02.AD	4700	4700	4700	4700	4700	4700
FPNE.05.AD	0	0	0	0	0	0
FPNF.01.AD	0	0	0	0	0	0
FPNG.01.AD	10800	0	0	0	0	0
FPNH.01.AD	0	0	0	0	0	0
FPSA.01.CCH	0	0	0	0	0	0
FPSA.06.CCH	22711	0	0	0	0	0
FPSB.01.CCH	0	0	0	0	0	0
FPSB.04.CCH	126400	126400	10000	10000	10000	10000
FPSD.01.CCH	380977	384831	261375	5270	0	0
FPSD.04.CCH	102790	104429	79436	519	0	0
FPSD.06.CCH	358783	364106	394757	462803	420337	399541
FPSE.01.CCH	10000	10000	10000	10000	10000	10000
FPSE.02.CCH	1733139	2403019	2260900	2266860	2279561	2254111
FPSF.01.EMW	286620	351660	338830	337430	316940	166030
FPSG.01.FS	530290	572250	651380	655840	670160	677770

	FY03	FY04	FY05	FY06	FY07	FY08
FPSH.01.FS	251740	295030	356520	360930	370010	373480
FPSJ.01.CCH	1064120	1175330	2056760	2059800	2108140	2126470
FPSL.01.CCH	376700	377100	806800	1260100	1991200	2049900
FPWB.01.IEW	116108	79832	80136	53044	88938	202200
FPWB.06.IEW	115817	191929	192034	233450	302155	278326
FPWC.01.EMW	0	0	0	0	0	0
FPWC.04.EMW	1400	1500	1300	0	0	0
FPWC.05.EMW	0	0	0	0	0	0
FPWC.06.EMW	16158	17015	5120	9629	11688	11688
FPWD.01.IEW	0	0	0	0	0	0
FPWD.04.IEW	0	0	0	0	0	0
FPXK.01.AD	0	0	0	0	0	0
FPXK.02.AD	0	0	0	0	0	0
FPXX.01.CCH	190750	185150	185150	185150	185150	185150
FPXX.06.CCH	0	0	0	0	0	0
FS01.01.FS	14000	0	0	0	0	0
FTMD.01.AD	0	0	0	0	0	0
LARM.01.FS	25200	0	0	0	0	0
LONG.01.FS	189600	113760	0	0	0	0
MPKA.01.C2	22980	7031	6392	4514	4584	4768
MPTK.01.CSS	17250	4650	5625	3375	10125	10125
MPTL.01.CSS	7164	7164	5940	5940	5940	5940
MPTM.01.CSS	26900	42900	51600	53300	41700	11168
MS2B.01.COM	10000	10000	10000	10000	10000	10000
MS5S.01.CSS	0	0	0	0	0	0
MT1A.01.COM	0	0	0	0	0	0
MT1D.01.C2	8000	8000	8000	8000	8000	8000
MT1G.01.CSS	38600	34100	31200	29100	22100	5670
MT1L.01.C2	13900	13300	11700	14800	0	0
MT5Y.01.COM	8945	9292	9657	10039	10441	10863
MX5T.01.COM	41250	41200	40450	40150	39150	39050
NEW.01.COM	820000	305000	815000	820000	820000	820000
PEWE.01.AVN	20000	20000	20000	20000	20000	20000
RA02.01.CSS	0	0	0	0	0	0
RA08.01.CCH	0	0	0	0	0	0
RA08.06.CCH	117711	121715	125850	128419	0	0
RA09.01.CCH	0	0	0	0	0	0
RA09.02.CCH	0	0	0	0	0	0
RA11.01.CCL	0	0	0	0	0	0
RA11.04.CCL	123210	123210	123210	47952	0	0
RA11.06.CCL	0	0	0	0	0	0
RA14.01.CCL	0	0	0	0	0	0
RA18.01.CCH	0	0	0	0	0	0
RA31.01.CCH	64212	20948	9808	10144	10488	10844
RA31.06.CCH	0	0	0	0	0	0
RB03.01.FS	0	0	0	0	0	0

	FY03	FY04	FY05	FY06	FY07	FY08
RB04.01.FS	0	0	0	0	0	0
RB07.01.FS	0	0	0	0	0	0
RB08.01.FS	0	0	0	0	0	0
RB12.01.FS	0	0	0	0	0	0
RB14.01.FS	0	0	0	0	0	0
RB16.01.FS	0	0	0	0	0	0
RB21.01.FS	311	312	313	314	315	316
RB25.01.FS	64000	33000	33000	0	0	0
RC01.01.AD	0	0	0	0	0	0
RC01.02.AD	0	0	0	0	0	0
RC02.01.AD	0	0	0	0	0	0
RC04.01.AD	228600	322900	253800	198000	0	0
RD06.01.AVN	750000	562000	650000	590000	450000	180000
RD07.01.AVN	3800	3800	3800	3800	3800	3800
RD07.04.AVN	6000	6000	5000	5000	5000	5000
RD12.01.AVN	3300	3300	3300	3300	3300	3300
RD12.02.AVN	0	0	0	0	0	0
RD13.01.AVN	48021	49653	51342	53088	54894	56760
RD15.01.AVN	12880	12985	13085	13185	13195	13195
RD16.01.AVN	12000	12000	12000	12000	12000	12000
RD17.01.AVN	8609	8695	8782	8870	9120	9370
RD18.01.AVN	6000	6000	6000	6000	6000	6000
RD19.01.AVN	60000	145000	185000	283000	457000	608000
RD22.01.AVN	0	0	0	0	0	0
RE02.01.CSS	0	0	0	0	0	0
RF01.01.EMW	13150	15480	15665	14140	14025	17000
RF02.01.EMW	39500	61500	52300	47600	46100	38500
RF02.02.EMW	0	0	0	0	0	0
RF03.01.EMW	9000	9000	9000	9000	9000	9000
RF03.04.EMW	0	0	0	0	0	0
RF03.06.EMW	34700	33600	32800	32900	32600	32700
RF06.01.EMW	12400	7700	9000	12200	13400	14000
RF07.01.EMW	0	0	0	0	0	0
RF08.01.EMW	0	0	0	0	0	0
RF09.01.EMW	0	0	0	0	0	0
RF09.06.EMW	30500	26200	0	0	0	0
RFAM.01.FS	78030	166175	166175	131495	0	0
RG03.01.NBC	53000	51000	54000	55000	28500	30000
RG04.01.NBC	129500	122300	111000	118000	129000	105000
RG05.01.NBC	32500	35500	35700	32000	31000	30000
RG06.01.NBC	37600	48500	54000	62000	69000	38000
RG06.02.NBC	0	0	0	0	0	0
RG06.03.NBC	0	0	0	0	0	0
RH09.01.C2	6010	6009	6010	6005	6004	6006
RH12.01.IEW	0	0	0	0	0	0

	FY03	FY04	FY05	FY06	FY07	FY08
RH12.04.IEW	8100	8300	8600	8800	9100	7200
RH13.01.IEW	0	0	0	0	0	0
RH13.04.IEW	1988	2903	2246	3191	2151	2896
RJ40.01.CSS	0	0	0	0	0	0
RJC0.01.CSS	4567	4723	4883	5050	5221	5398
RJC5.01.CSS	9265	9581	9906	10242	10591	10951
RJC6.01.CSS	26900	26900	26900	26900	26900	26900
RJC7.01.CSS	55040	41670	44384	51951	36048	6690
RJC9.01.CSS	5755	6090	5935	6090	6175	6100
RJCA.01.CSS	27500	29000	28450	29150	29000	29000
RJCB.01.CSS	0	0	0	0	0	0
RJL3.01.CSS	0	0	0	0	0	0
RJL4.01.CSS	0	0	0	0	0	0
RJL4.02.CSS	0	0	0	0	0	0
RJL5.01.CSS	0	0	0	0	0	0
RJL6.01.CSS	0	0	0	0	0	0
RJL7.01.CSS	27800	25300	25550	25550	12050	12050
RJL8.01.CSS	21900	22450	26100	23800	23225	19475
RJM1.01.CSS	134300	138900	143500	148400	153400	158700
RJM2.01.CSS	47678	48274	46987	46614	46750	47507
RJM3.01.CSS	0	0	0	0	0	0
RJS1.01.CSS	176569	179872	177288	189726	49461	51079
RJS2.01.CSS	5250	5250	5250	5250	5250	5250
RJS2.05.CSS	5925	5875	5875	5875	1650	1650
RJT0.01.CSS	0	0	0	0	0	0
RJT2.01.CSS	0	0	0	0	0	0
RJT3.01.CSS	0	0	0	0	0	0
RJT7.01.CSS	1960	2030	2090	2170	2240	2320
RJT8.01.EMW	10600	14800	15000	15200	15400	0
RJT9.01.CSS	6535	6535	3835	3835	3835	3835
RK1X.03.FS	2700	0	0	0	0	0
TA18.01.IEW	0	0	0	0	0	0
TA18.04.IEW	3253	3253	3253	3253	3253	3253
TA35.01.IEW	0	0	0	0	0	0
TA35.04.IEW	1521	1521	1521	1521	1521	1521
XXX3.01.CCL	0	0	0	0	0	0

;

INCLUDE File FORCEMOD.LGC for Logical Constraints

EQUATIONS

```
EXCLUSIV1    don't fund mutually exclusive MDEPs
EXCLUSIV2    don't fund mutually exclusive MDEPs
EXCLUSIV3    don't fund mutually exclusive MDEPs
EXCLUSIV4    don't fund mutually exclusive MDEPs
EXCLUSIV5    don't fund mutually exclusive MDEPs

SUB1         don't fund mutually exclusive MDEP subsets
SUB2         don't fund mutually exclusive MDEP subsets
SUB3         don't fund mutually exclusive MDEP subsets
SUB4         don't fund mutually exclusive MDEP subsets
SUB5         don't fund mutually exclusive MDEP subsets

COMP1        fund complementary MDEPs
COMP2        fund complementary MDEPs
COMP3        fund complementary MDEPs
COMP4        fund complementary MDEPs
COMP5        fund complementary MDEPs
COMP6        fund complementary MDEPs
COMP7        fund complementary MDEPs
COMP8        fund complementary MDEPs
COMP9        fund complementary MDEPs
COMP10       fund complementary MDEPs
COMP11       fund complementary MDEPs
COMP12       fund complementary MDEPs
COMP13       fund complementary MDEPs
COMP14       fund complementary MDEPs
COMP15       fund complementary MDEPs
COMP16       fund complementary MDEPs
COMP17       fund complementary MDEPs
COMP18       fund complementary MDEPs
COMP19       fund complementary MDEPs
;
```

*** formulation of logical constraints**

*** don't fund mutually exclusive MDEPs**

```
EXCLUSIV1..    Z("FPHB","01") + Z("FPSG","01") =L= 1.0 ;

EXCLUSIV2..    Z("FPSF","01") + Z("RF08","01") =L= 1.0 ;
```

```
EXCLUSIV3..     Z("FPSB","01") + Z("FPSJ","01")
              + Z("RA09","01") =L= 1.0 ;

EXCLUSIV4..     Z("FPSD","01") + Z("FPNB","01")
              + Z("FPDC","01") =L= 1.0 ;

EXCLUSIV5..     Z("FPXX","01") + Z("FPLK","02")
              + Z("FPSD","01") =L= 1.0 ;

* don't fund mutually exclusive MDEP subsets

SUB1..          Z("FPEA","01") =E= Z("FPEL","02") ;
SUB2..          Z("FPEA","01") =E= Z("FPEL","05") ;
SUB3..          Z("FPEA","01") + Z("FPGA","01") =L= 1.0 ;

SUB4..          Z("FPSA","01") =E= Z("FPSA","06") ;
SUB5..          Z("FPSA","01") + Z("FPSE","01") =L= 1.0 ;

* fund complementary MDEPs

COMP1..         Z("FPSG","01") =E= Z("FPSH","01") ;
COMP2..         Z("FPHB","01") =E= Z("FL6X","01") ;

COMP3..         Z("RA08","01") =E= Z("FPSE","01") ;
COMP4..         Z("RA08","01") =E= Z("RF01","01") ;
COMP5..         Z("RA08","01") =E= Z("RF08","01") ;

COMP6..         Z("FPLF","01") =E= Z("FPFL","01") ;
COMP7..         Z("FPLF","01") =E= Z("FPHC","01") ;
COMP8..         Z("FPLF","01") =E= Z("FPLG","01") ;
COMP9..         Z("FPLF","01") =E= Z("FPLX","01") ;
COMP10..        Z("FPLF","01") =E= Z("FPLC","01") ;
COMP11..        Z("FPLF","01") =E= Z("FPJA","01") ;

COMP12..        Z("FPEA","01") =E= Z("FPED","01") ;
COMP13..        Z("FPEA","01") =E= Z("FPEE","01") ;
COMP14..        Z("FPEA","01") =E= Z("FPLE","01") ;

COMP15..        Z("FPFP","01") =E= Z("FPWB","01") ;
COMP16..        Z("FPFP","01") =E= Z("FPFL","01") ;
COMP17..        Z("FPFP","01") =E= Z("FPFK","01") ;
COMP18..        Z("FPFP","01") =E= Z("FPFB","01") ;
COMP19..        Z("FPFP","01") =E= Z("FPWC","01") ;
```

APPENDIX D GAMS OUTPUT FILE - CONSTRAINED BUDGET

```
*************************************************************

** Optimization Model for Army Planning and Programming **
**          Post-Optimization Summary Reports            **
*************************************************************
```

---- 1010 PARAMETER OBJREP   Breakdown of objective function

WARVAL	919.8947
NBAL1	0.0217
PBAL1	0.0180
NBAL2	0.0074
PBAL2	0.0026
NTURB	2.973903E-6
TOTAL	919.9440

---- 1049 PARAMETER YEARSUM   Summary Report of Funding by Fiscal Year

	TOTASPIRE	TOTFUND	BUDGET	UNSPENT
FY94	12580602	10000000	10000000	
FY95	13545118	10000000	10000000	
FY96	15468945	10000000	10000000	
FY97	16393602	10000000	10000000	
FY98	17918906	10000000	10000000	
FY99	18608527	11000000	11000000	
FY00	18194496	11000000	11000000	
FY01	17735495	11000000	11000000	
FY02	18623175	11000000	11000000	
FY03	18801090	11000000	11000000	
FY04	18432677	10715967	12000000	1284033
FY05	19270644	10880801	12000000	1119199
FY06	18580354	10628643	12000000	1371357
FY07	18502891	10653828	12000000	1346172
FY08	18024088	10346266	12000000	1653734

— 1072 PARAMETER MISNSUM Summary Report of Funding by Mission Area

	TOTASPIRE	TOTFUND	PCT-FUNDED	PCT-BUDGET	PCT-ALLOC
COM	19246639.0	16443379.2	85.4	10.0	10.4
C2	2645126.0	2645126.0	100.0	1.6	1.7
IEW	10710561.0	10364055.8	96.8	6.3	6.6
EMW	6456307.0	5445313.0	84.3	3.3	3.4
AD	13599647.0	10650439.8	78.3	6.5	6.7
FS	34202314.0	29633763.0	86.6	18.0	18.7
CSS	29636182.0	28421353.4	95.9	17.2	18.0
AVN	63464108.0	23021307.5	36.3	14.0	14.5
CCL	10357654.0	8412676.8	81.2	5.1	5.3
CCH	66548032.0	19374050.5	29.1	11.7	12.2
NBC	3814040.0	3814040.0	100.0	2.3	2.4
TOTAL	260680610.0	158225505.1	60.7	95.9	100.0
BUDGET		165000000.0		100.0	
UNSPENT		6774495.0		4.1	

— 1083 PARAMETER BALSUM Summary Report of Mission Area Balance

	PCT-ASPIRE	DESIRED	PCT-ALLOC
COM	7.38	8.00	10.39
C2	1.01	3.00	1.67
IEW	4.11	6.00	6.55
EMW	2.48	3.00	3.44
AD	5.22	4.00	6.73
FS	13.12	16.00	18.73
CSS	11.37	14.00	17.96
AVN	24.35	20.00	14.55
CCL	3.97	9.00	5.32
CCH	25.53	13.00	12.24
NBC	1.46	4.00	2.41

— 1092 PARAMETER WARREP Summary of Warfighting Value

	IDEAL	ACTUAL
FY94	158.213	144.261
FY95	274.547	250.289
FY96	378.530	342.515
FY97	459.995	413.752
FY98	528.324	471.941
FY99	588.703	521.509
FY00	640.540	562.441
FY01	687.619	595.754
FY02	730.456	625.621
FY03	768.125	652.463
FY04	805.432	678.698

	IDEAL	ACTUAL
FY05	841.534	703.628
FY06	876.052	727.463
FY07	909.343	749.866
FY08	941.320	770.924

— 1111 PARAMETER FUNDREP - Summary Report of Funded Projects

		TOTASPIRE	TOTFUND	PCT-FUNDED
FA0A	.01	45000.00	45000.00	100.00
FL6P	.01	752396.00	752396.00	100.00
FL6Q	.01	24100.00	24100.00	100.00
FL6V	.02	78.00	78.00	100.00
FL6Y	.01	286100.00	286100.00	100.00
FL8D	.01	404750.00	404750.00	100.00
FL8G	.01	1471987.00	1471987.00	100.00
FPAV	.01	3560700.00	2992992.06	84.06
FPDA	.01	46180.00	46180.00	100.00
FPDA	.02	190906.00	190906.00	100.00
FPDB	.01	456892.00	456892.00	100.00
FPDB	.04	136100.00	136100.00	100.00
FPDB	.05	78500.00	78500.00	100.00
FPDB	.06	1836800.00	1642750.03	89.44
FPDC	.01	151487.00	151487.00	100.00
FPDC	.06	177178.00	177178.00	100.00
FPDD	.01	1299497.00	1299497.00	100.00
FPDE	.01	1955038.00	1908763.66	97.63
FPDE	.02	2991210.00	2392968.10	80.00
FPDF	.01	57490.00	57490.00	100.00
FPDG	.01	380760.00	380760.00	100.00
FPDH	.01	113396.00	113396.00	100.00
FPDH	.04	338806.00	338806.00	100.00
FPDK	.01	302775.00	302775.00	100.00
FPDL	.01	550448.00	550448.00	100.00
FPDM	.01	361453.00	216871.80	60.00
FPDP	.01	1276581.00	1276581.00	100.00
FPDQ	.01	11527.00	11527.00	100.00
FPDQ	.02	650800.00	520639.96	80.00
FPEA	.01	609387.00	609387.00	100.00
FPEA	.02	129000.00	129000.00	100.00
FPED	.01	375000.00	375000.00	100.00
FPED	.04	487089.00	487089.00	100.00
FPEE	.01	194949.00	194949.00	100.00
FPEE	.02	299435.00	299435.00	100.00
FPEF	.01	295201.00	295201.00	100.00
FPEG	.01	1458705.00	1458705.00	100.00
FPEG	.04	120300.00	120300.00	100.00
FPEH	.01	115877.00	115877.00	100.00
FPEH	.04	76700.00	76700.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
FPEL	.02	5313792.00	4251033.46	80.00
FPEL	.05	1728400.00	1728400.00	100.00
FPEM	.01	1643.00	1643.00	100.00
FPEN	.04	76396.00	76396.00	100.00
FPEP	.01	286416.00	286416.00	100.00
FPEP	.06	43051.00	43051.00	100.00
FPEQ	.01	1386270.00	831762.03	60.00
FPFB	.01	404080.00	404080.00	100.00
FPFC	.01	38862.00	38862.00	100.00
FPFJ	.01	327350.00	327350.00	100.00
FPFK	.01	287752.00	287752.00	100.00
FPFL	.01	705731.00	705731.00	100.00
FPFM	.01	86183.00	86183.00	100.00
FPFM	.05	66369.00	66369.00	100.00
FPFP	.01	550900.00	550900.00	100.00
FPHC	.01	3834052.00	3834052.00	100.00
FPHD	.01	1068.00	1068.00	100.00
FPHE	.01	213334.00	213334.00	100.00
FPHE	.02	389091.00	389091.00	100.00
FPHE	.03	79300.00	79300.00	100.00
FPJA	.01	1036806.00	1036806.00	100.00
FPJA	.02	1774463.00	1774463.00	100.00
FPJA	.04	22491.00	22491.00	100.00
FPJB	.01	695968.00	695968.00	100.00
FPJB	.02	829504.00	814469.00	98.19
FPJB	.04	44016.00	44016.00	100.00
FPJC	.01	8278850.00	8278850.00	100.00
FPJC	.02	3232000.00	2863000.00	88.58
FPJC	.04	22491.00	22491.00	100.00
FPJC	.06	548523.00	438818.40	80.00
FPLB	.01	2806215.00	2806215.00	100.00
FPLC	.01	697355.00	697355.00	100.00
FPLE	.01	179761.00	179761.00	100.00
FPLF	.01	4609083.00	4609083.00	100.00
FPLF	.04	254414.00	254414.00	100.00
FPLG	.01	313500.00	313500.00	100.00
FPLK	.01	700983.00	700983.00	100.00
FPLX	.01	4443561.00	4443561.00	100.00
FPLZ	.01	2727368.00	2727368.00	100.00
FPMA	.01	630283.00	630283.00	100.00
FPMB	.01	188462.00	188462.00	100.00
FPMC	.01	727672.00	727672.00	100.00
FPMC	.05	143700.00	143700.00	100.00
FPMD	.01	2047320.00	2047320.00	100.00
FPMH	.02	2222819.00	1778255.23	80.00
FPMH	.03	817162.00	653729.62	80.00
FPMJ	.01	1512332.00	1512332.00	100.00
FPMJ	.05	144835.00	144835.00	100.00
FPMK	.01	666772.00	666772.00	100.00
FPMK	.04	232000.00	232000.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
FPMK	.06	502553.00	402042.40	80.00
FPMM	.01	2048522.00	2048522.00	100.00
FPNA	.01	5256118.00	3153670.85	60.00
FPNC	.01	527576.00	527576.00	100.00
FPNC	.03	1795000.00	1795000.00	100.00
FPNE	.02	239022.00	239022.00	100.00
FPNF	.01	1095678.00	1095678.00	100.00
FPNG	.01	416157.00	391657.00	94.11
FPNH	.01	3700.00	3700.00	100.00
FPSA	.01	746814.00	746814.00	100.00
FPSA	.06	6052849.00	6052849.00	100.00
FPSB	.01	365506.00	365506.00	100.00
FPSB	.04	1052000.00	841599.99	80.00
FPSF	.01	2923196.00	2923196.00	100.00
FPSG	.01	6015816.00	6015816.00	100.00
FPSH	.01	2642575.00	2642575.00	100.00
FPSL	.01	8639900.00	6485100.00	75.06
FPWB	.01	1929687.00	1929687.00	100.00
FPWB	.06	1406353.00	1398479.00	99.44
FPWC	.01	179790.00	179790.00	100.00
FPWC	.04	15591.00	15591.00	100.00
FPWC	.05	73831.00	73831.00	100.00
FPWC	.06	123949.00	123949.00	100.00
FPWD	.04	44383.00	44383.00	100.00
FPXK	.02	708651.00	708651.00	100.00
FPXX	.01	2224850.00	1833333.55	82.40
FPXX	.06	38133.00	38133.00	100.00
FS01	.01	90000.00	90000.00	100.00
LARM	.01	10790.00	107900.00	100.00
LONG	.01	83108.00	767880.00	92.40
MPKA	.01	277245.00	277245.00	100.00
MPTK	.01	132396.00	132396.00	100.00
MPTL	.01	108036.00	108036.00	100.00
MPTM	.01	383716.00	383716.00	100.00
MS2B	.01	109344.00	109344.00	100.00
MS5S	.01	7829.00	7829.00	100.00
MT1A	.01	44357.00	44357.00	100.00
MT1D	.01	120000.00	120000.00	100.00
MT1G	.01	503964.00	503964.00	100.00
MT1L	.01	603161.00	603161.00	100.00
MT5Y	.01	131841.00	131841.00	100.00
MX5T	.01	809348.00	809348.00	100.00
NEW	.01	5565000.00	4802846.91	86.30
PEWE	.01	301183.00	301183.00	100.00
RA02	.01	88255.00	88255.00	100.00
RA11	.01	138363.00	138363.00	100.00
RA11	.04	714684.00	714684.00	100.00
RA11	.06	28000.00	28000.00	100.00
RA14	.01	53450.00	53450.00	100.00
RA18	.01	974734.00	974734.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
RA31	.01	872765.00	523658.99	60.00
RA31	.06	129614.00	129614.00	100.00
RB04	.01	67822.00	67822.00	100.00
RB07	.01	58440.00	58440.00	100.00
RB12	.01	29900.00	29900.00	100.00
RB14	.01	5116.00	5116.00	100.00
RB16	.01	40000.00	40000.00	100.00
RB21	.01	4635.00	4635.00	100.00
RB25	.01	437000.00	437000.00	100.00
RC01	.02	10166.00	10166.00	100.00
RC02	.01	98472.00	98472.00	100.00
RC04	.01	1270900.00	1270900.00	100.00
RD06	.01	5412000.00	4462000.00	82.45
RD07	.01	57000.00	57000.00	100.00
RD07	.04	195979.00	195979.00	100.00
RD12	.01	49500.00	49500.00	100.00
RD12	.02	37466.00	37466.00	100.00
RD13	.01	605042.00	584090.00	96.54
RD15	.01	184663.00	184663.00	100.00
RD16	.01	181368.00	181368.00	100.00
RD17	.01	124436.00	124436.00	100.00
RD18	.01	484525.00	484525.00	100.00
RD19	.01	1768800.00	1768800.00	100.00
RD22	.01	37200.00	37200.00	100.00
RE02	.01	147100.00	147100.00	100.00
RF02	.01	727708.00	727708.00	100.00
RF02	.02	149807.00	129834.00	86.67
RF03	.01	135000.00	135000.00	100.00
RF03	.04	23100.00	23100.00	100.00
RF03	.06	447600.00	358080.02	80.00
RF06	.01	134358.00	134358.00	100.00
RF07	.01	46020.00	46020.00	100.00
RF09	.01	200826.00	200826.00	100.00
RF09	.06	244300.00	207200.00	84.81
RFAM	.01	630675.00	630675.00	100.00
RG03	.01	627637.00	627637.00	100.00
RG04	.01	2000578.00	2000578.00	100.00
RG05	.01	385630.00	385630.00	100.00
RG06	.01	689985.00	689985.00	100.00
RG06	.02	1610.00	1610.00	100.00
RG06	.03	108600.00	108600.00	100.00
RH09	.01	91187.00	91187.00	100.00
RH12	.01	48489.00	48489.00	100.00
RH12	.04	72800.00	72800.00	100.00
RH13	.01	1276.00	1276.00	100.00
RH13	.04	31327.00	31327.00	100.00
RJ40	.01	221980.00	221980.00	100.00
RJC0	.01	138889.00	138889.00	100.00
RJC5	.01	211222.00	211222.00	100.00
RJC6	.01	449496.00	449496.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
RJC7	.01	688031.00	688031.00	100.00
RJC9	.01	633803.00	633803.00	100.00
RJCA	.01	708374.00	708374.00	100.00
RJCB	.01	24963.00	24963.00	100.00
RJL4	.01	204169.00	204169.00	100.00
RJL4	.02	233000.00	233000.00	100.00
RJL5	.01	31102.00	31102.00	100.00
RJL6	.01	7984.00	7984.00	100.00
RJL7	.01	354014.00	354014.00	100.00
RJL8	.01	351673.00	351673.00	100.00
RJM1	.01	1966219.00	1828047.00	92.97
RJM2	.01	700710.00	700710.00	100.00
RJM3	.01	555.00	555.00	100.00
RJS1	.01	1564783.00	1564783.00	100.00
RJS2	.01	84047.00	84047.00	100.00
RJS2	.05	233815.00	233815.00	100.00
RJT0	.01	39900.00	39900.00	100.00
RJT3	.01	67035.00	67035.00	100.00
RJT7	.01	36873.00	36873.00	100.00
RJT8	.01	158830.00	142730.00	89.86
RJT9	.01	79731.00	79731.00	100.00
RK1X	.03	23000.00	23000.00	100.00
TA18	.01	3253.00	3253.00	100.00
TA18	.04	42289.00	42289.00	100.00
TA35	.04	21772.00	21772.00	100.00
XXX3	.01	40500.00	40500.00	100.00
TOTAL.FUNDED		2.606806E+8	1.582255E+8	60.70

— 1128 PARAMETER UNFUNDREP Summary Report of Unfunded Projects

		WARVAL	TOTASPIRE	UNFUNDED
FL6X	.01	3.52	98700.00	1.00
FL6X	.02	0.44	111500.00	1.00
FPGA	.01	48.50	35381174.00	1.00
FPGA	.02	45.45	1905700.00	1.00
FPHB	.01	3.52	620551.00	1.00
FPJB	.06	0.13	582917.00	1.00
FPLF	.06	0.15	1778500.00	1.00
FPLG	.02	0.15	1896100.00	1.00
FPLK	.02	0.80	1253500.00	1.00
FPLK	.04	0.20	1341264.00	1.00
FPMM	.04	0.20	1332600.00	1.00
FPNB	.01	25.80	1300461.00	1.00
FPNE	.05	0.12	692100.00	1.00
FPSD	.01	6.86	4385149.00	1.00
FPSD	.04	0.29	1381651.00	1.00
FPSD	.06	0.29	3496890.00	1.00

	WARVAL	TOTASPIRE	UNFUNDED
FPSE .01	15.64	717622.00	1.00
FPSE .02	4.44	17100303.00	1.00
FPSJ .01	1.62	12909581.00	1.00
RA08 .01	3.23	256148.00	1.00
RA08 .06	0.16	1086904.00	1.00
RA09 .01	3.23	127800.00	1.00
RA09 .02	0.20	11347.00	1.00
RF01 .01	1.61	240053.00	1.00
RF08 .01	1.67	608248.00	1.00
TOTAL.UNFUNDED	168.22	90616763.00	25.00

— 1148 PARAMETER EXCLUDREP Summary Report of Excluded Projects

	WARVAL	TOTASPIRE	EXCLUDED
ACE3 .01	3.84		1.00
FL6V .01	2.84		1.00
FPED .02	3.03	305349.00	1.00
FPEL .01	4.86		1.00
FPEN .01	6.07		1.00
FPMH .01	3.36		1.00
FPNE .01	2.84		1.00
FPWD .01	1.28		1.00
FPXK .01	0.68		1.00
FTMD .01	6.80		1.00
RB03 .01	8.36		1.00
RB08 .01	0.15		1.00
RC01 .01	2.55		1.00
RJL3 .01	2.27		1.00
RJT2 .01	2.31		1.00
TA35 .01	1.44		1.00
TOTAL.EXCLUDED	52.68	305349.00	16.00

— 1168 PARAMETER MISNREP Funding Report by Mission Area as Per Cent of Budget

INDEX 1 = FY94

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	12.09	0.09
C2	1.00	3.00	6.00	2.39	
IEW	3.00	6.00	9.00	7.38	
EMW	1.00	3.00	6.00	2.12	
AD	2.00	4.00	8.00	6.26	
FS	10.00	16.00	20.00	17.01	
CSS	10.00	14.00	20.00	16.98	
AVN	12.00	20.00	30.00	17.01	
CCL	5.00	9.00	15.00	6.30	

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
CCH	8.00	13.00	18.00	9.43	
NBC	2.00	4.00	7.00	3.03	

INDEX 1 = FY95

	MINIMUM	DESIRED	MAXIMUM	ACTUAL
COM	4.00	8.00	12.00	11.59
C2	1.00	3.00	6.00	2.54
IEW	3.00	6.00	9.00	6.11
EMW	1.00	3.00	6.00	2.69
AD	2.00	4.00	8.00	6.33
FS	10.00	16.00	20.00	19.53
CSS	10.00	14.00	20.00	15.25
AVN	12.00	20.00	30.00	13.03
CCL	5.00	9.00	15.00	7.29
CCH	8.00	13.00	18.00	12.99
NBC	2.00	4.00	7.00	2.64

INDEX 1 = FY96

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	11.14	
C2	1.00	3.00	6.00	3.24	
IEW	3.00	6.00	9.00	6.35	
EMW	1.00	3.00	6.00	1.98	
AD	2.00	4.00	8.00	6.65	
FS	10.00	16.00	20.00	19.54	
CSS	10.00	14.00	20.00	17.87	
AVN	12.00	20.00	30.00	10.51	-1.49
CCL	5.00	9.00	15.00	6.54	
CCH	8.00	13.00	18.00	12.95	
NBC	2.00	4.00	7.00	3.22	

INDEX 1 = FY97

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	9.07	
C2	1.00	3.00	6.00	3.04	
IEW	3.00	6.00	9.00	6.32	
EMW	1.00	3.00	6.00	2.63	
AD	2.00	4.00	8.00	7.77	
FS	10.00	16.00	20.00	17.80	
CSS	10.00	14.00	20.00	18.42	
AVN	12.00	20.00	30.00	10.20	-1.80

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
CCL	5.00	9.00	15.00	6.64	
CCH	8.00	13.00	18.00	15.12	
NBC	2.00	4.00	7.00	2.99	

INDEX 1 = FY98

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.49	
C2	1.00	3.00	6.00	2.69	
IEW	3.00	6.00	9.00	6.82	
EMW	1.00	3.00	6.00	3.25	
AD	2.00	4.00	8.00	7.73	
FS	10.00	16.00	20.00	20.04	0.04
CSS	10.00	14.00	20.00	18.26	
AVN	12.00	20.00	30.00	9.83	-2.17
CCL	5.00	9.00	15.00	6.28	
CCH	8.00	13.00	18.00	15.50	
NBC	2.00	4.00	7.00	2.12	

INDEX 1 = FY99

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.30	
C2	1.00	3.00	6.00	2.45	
IEW	3.00	6.00	9.00	5.71	
EMW	1.00	3.00	6.00	3.55	
AD	2.00	4.00	8.00	8.59	0.59
FS	10.00	16.00	20.00	18.67	
CSS	10.00	14.00	20.00	16.97	
AVN	12.00	20.00	30.00	13.37	
CCL	5.00	9.00	15.00	5.98	
CCH	8.00	13.00	18.00	15.33	
NBC	2.00	4.00	7.00	2.08	

INDEX 1 = FY00

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.53	
C2	1.00	3.00	6.00	2.15	
IEW	3.00	6.00	9.00	4.71	
EMW	1.00	3.00	6.00	3.48	
AD	2.00	4.00	8.00	7.11	
FS	10.00	16.00	20.00	18.85	
CSS	10.00	14.00	20.00	20.09	0.09

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
AVN	12.00	20.00	30.00	14.92	
CCL	5.00	9.00	15.00	6.99	
CCH	8.00	13.00	18.00	12.06	
NBC	2.00	4.00	7.00	2.11	

INDEX 1 = FY01

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.12	
C2	1.00	3.00	6.00	1.29	
IEW	3.00	6.00	9.00	5.39	
EMW	1.00	3.00	6.00	3.27	
AD	2.00	4.00	8.00	7.02	
FS	10.00	16.00	20.00	19.19	
CSS	10.00	14.00	20.00	21.77	1.77
AVN	12.00	20.00	30.00	16.82	
CCL	5.00	9.00	15.00	5.16	
CCH	8.00	13.00	18.00	10.57	
NBC	2.00	4.00	7.00	2.39	

INDEX 1 = FY02

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	11.93	
C2	1.00	3.00	6.00	1.21	
IEW	3.00	6.00	9.00	5.89	
EMW	1.00	3.00	6.00	3.98	
AD	2.00	4.00	8.00	7.41	
FS	10.00	16.00	20.00	21.96	1.96
CSS	10.00	14.00	20.00	19.67	
AVN	12.00	20.00	30.00	15.93	
CCL	5.00	9.00	15.00	5.17	
CCH	8.00	13.00	18.00	5.05	-2.95
NBC	2.00	4.00	7.00	1.80	-0.20

INDEX 1 = FY03

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	12.68	0.68
C2	1.00	3.00	6.00	1.22	
IEW	3.00	6.00	9.00	8.87	
EMW	1.00	3.00	6.00	4.01	
AD	2.00	4.00	8.00	7.79	

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
FS	10.00	16.00	20.00	21.97	1.97
CSS	10.00	14.00	20.00	17.06	
AVN	12.00	20.00	30.00	15.49	
CCL	5.00	9.00	15.00	4.96	-0.04
CCH	8.00	13.00	18.00	3.67	-4.33
NBC	2.00	4.00	7.00	2.30	

INDEX 1 = FY04

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.48	
C2	1.00	3.00	6.00	1.08	
IEW	3.00	6.00	9.00	9.62	0.62
EMW	1.00	3.00	6.00	4.36	
AD	2.00	4.00	8.00	6.48	
FS	10.00	16.00	20.00	17.79	
CSS	10.00	14.00	20.00	15.65	
AVN	12.00	20.00	30.00	14.03	
CCL	5.00	9.00	15.00	4.75	-0.25
CCH	8.00	13.00	18.00	5.91	-2.09
NBC	2.00	4.00	7.00	2.14	
UNSPENT				11.00	

INDEX 1 = FY05

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	10.90	
C2	1.00	3.00	6.00	0.50	-0.50
IEW	3.00	6.00	9.00	6.30	
EMW	1.00	3.00	6.00	3.86	
AD	2.00	4.00	.8.00	5.55	
FS	10.00	16.00	20.00	18.25	
CSS	10.00	14.00	20.00	15.93	
AVN	12.00	20.00	30.00	15.11	
CCL	5.00	9.00	15.00	3.72	-1.28
CCH	8.00	13.00	18.00	8.43	
NBC	2.00	4.00	7.00	2.12	
UNSPENT				9.00	

INDEX 1 = FY06

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	11.09	
C2	1.00	3.00	6.00	0.49	-0.51
IEW	3.00	6.00	9.00	4.63	
EMW	1.00	3.00	6.00	3.87	
AD	2.00	4.00	8.00	6.76	
FS	10.00	16.00	20.00	13.93	
CSS	10.00	14.00	20.00	16.08	
AVN	12.00	20.00	30.00	14.28	
CCL	5.00	9.00	15.00	3.02	-1.98
CCH	8.00	13.00	18.00	12.21	
NBC	2.00	4.00	7.00	2.22	
UNSPENT				11.00	

INDEX 1 = FY07

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	11.14	
C2	1.00	3.00	6.00	0.37	-0.63
IEW	3.00	6.00	9.00	5.33	
EMW	1.00	3.00	6.00	3.71	
AD	2.00	4.00	8.00	2.71	
FS	10.00	16.00	20.00	13.13	
CSS	10.00	14.00	20.00	14.77	
AVN	12.00	20.00	30.00	14.59	
CCL	5.00	9.00	15.00	2.59	-2.41
CCH	8.00	13.00	18.00	18.31	0.31
NBC	2.00	4.00	7.00	2.15	
UNSPENT				11.00	

INDEX 1 = FY08

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	10.91	
C2	1.00	3.00	6.00	0.38	-0.62
IEW	3.00	6.00	9.00	5.00	
EMW	1.00	3.00	6.00	2.27	
AD	2.00	4.00	8.00	3.54	
FS	10.00	16.00	20.00	13.33	
CSS	10.00	14.00	20.00	14.50	
AVN	12.00	20.00	30.00	13.21	
CCL	5.00	9.00	15.00	2.59	-2.41
CCH	8.00	13.00	18.00	18.80	0.80
NBC	2.00	4.00	7.00	1.69	-0.31
UNSPENT				14.00	

— 1179 PARAMETER TURBREP **Report of Funding Turbulence**

	NTURB	X(IJ,T-1)	X(IJ,T)
FPDE.01.FY96	0.178	1.000	0.722
FPDM.01.FY96	0.823	0.914	
FPDM.01.FY98	0.900	1.000	
FPDQ.02.FY95	0.900	1.000	
FPEL.02.FY95	0.621	1.000	0.279
FPEL.02.FY96	0.251	0.279	
FPEL.02.FY98	0.408	1.000	0.492
FPJB.02.FY96	0.900	1.000	
FPMH.02.FY95	0.900	1.000	
FPMK.06.FY96	0.842	1.000	0.058
FPNA.01.FY95	0.078	0.087	
FPNG.01.FY96	0.900	1.000	
FPXX.01.FY95	0.900	1.000	
FPXX.01.FY98	0.283	0.314	
RA31.01.FY98	0.484	0.538	
RD13.01.FY96	0.900	1.000	
RF02.02.FY96	0.900	1.000	
RF09.06.FY96	0.900	1.000	
RJM1.01.FY96	0.900	1.000	

APPENDIX E GAMS OUTPUT FILE - UNCONSTRAINED BUDGET

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*************************************************************
**  Optimization Model for Army Planning and Programming  **
**           Post-Optimization Summary Reports             **
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— 1010 PARAMETER OBJREP Breakdown of objective function

WARVAL	894.8217
NBAL1	0.0479
PBAL1	0.0014
NBAL2	0.0372
TOTAL	894.9090

— 1049 PARAMETER YEARSUM Summary Report of Funding by Fiscal Year

	TOTASPIRE	TOTFUND	BUDGET	UNSPENT
FY94	12580602	10833789	20000000	9166211
FY95	13545118	11706610	20000000	8293390
FY96	15468945	13232472	20000000	6767528
FY97	16393602	12547061	20000000	7452939
FY98	17918906	13524991	20000000	6475009
FY99	18608527	13704389	20000000	6295611
FY00	18194496	12743658	20000000	7256342
FY01	17735495	12316900	20000000	7683100
FY02	18623175	12009633	20000000	7990367
FY03	18801090	11833420	20000000	8166580
FY04	18432677	10718167	20000000	9281833
FY05	19270644	10883101	20000000	9116899
FY06	18580354	10631043	20000000	9368957
FY07	18502891	10654828	20000000	9345172
FY08	18024088	10347266	20000000	9652734

— 1072 PARAMETER MISNSUM Summary Report of Funding by Mission Area

	TOTASPIRE	TOTFUND	PCT-FUNDED	PCT-BUDGET	PCT-ALLOC
COM	19246639.0	19246639.0	100.0	6.4	10.8
C2	2645126.0	2645126.0	100.0	0.9	1.5
IEW	10710561.0	10710561.0	100.0	3.6	6.0
EMW	6456307.0	5608006.0	86.9	1.9	3.2
AD	13599647.0	13599647.0	100.0	4.5	7.7
FS	34202314.0	33371563.0	97.6	11.1	18.8
CSS	29636182.0	29636182.0	100.0	9.9	16.7
AVN	63464108.0	26177234.0	41.2	8.7	14.7
CCL	10357654.0	9057193.0	87.4	3.0	5.1
CCH	66548032.0	23821137.0	35.8	7.9	13.4
NBC	3814040.0	3814040.0	100.0	1.3	2.1
TOTAL	260680610.0	177687328.0	68.2	59.2	100.0
BUDGET		300000000.0		100.0	
UNSPENT		122312672.0		40.8	

— 1083 PARAMETER BALSUM Summary Report of Mission Area Balance

	PCT-ASPIRE	DESIRED	PCT-ALLOC
COM	7.38	8.00	10.83
C2	1.01	3.00	1.49
IEW	4.11	6.00	6.03
EMW	2.48	3.00	3.16
AD	5.22	4.00	7.65
FS	13.12	16.00	18.78
CSS	11.37	14.00	16.68
AVN	24.35	20.00	14.73
CCL	3.97	9.00	5.10
CCH	25.53	13.00	13.41
NBC	1.46	4.00	2.15

— 1092 PARAMETER WARREP Summary of Warfighting Value

	IDEAL	ACTUAL
FY94	158.213	144.446
FY95	274.547	250.880
FY96	378.530	343.954
FY97	459.995	415.682
FY98	528.324	474.506
FY99	588.703	524.357
FY00	640.540	565.393
FY01	687.619	598.778
FY02	730.456	628.707
FY03	768.125	655.588
FY04	805.432	681.823

	IDEAL	ACTUAL
FY05	841.534	706.754
FY06	876.052	730.589
FY07	909.343	752.992
FY08	941.320	774.050

— 1111 PARAMETER FUNDREP **Summary Report of Funded Projects**

		TOTASPIRE	TOTFUND	PCT-FUNDED
FA0A	.01	45000.00	45000.00	100.00
FL6P	.01	752396.00	752396.00	100.00
FL6Q	.01	24100.00	24100.00	100.00
FL6V	.02	78.00	78.00	100.00
FL6Y	.01	286100.00	286100.00	100.00
FL8D	.01	404750.00	404750.00	100.00
FL8G	.01	1471987.00	1471987.00	100.00
FPAV	.01	3560700.00	3560700.00	100.00
FPDA	.01	46180.00	46180.00	100.00
FPDA	.02	190906.00	190906.00	100.00
FPDB	.01	456892.00	456892.00	100.00
FPDB	.04	136100.00	136100.00	100.00
FPDB	.05	78500.00	78500.00	100.00
FPDB	.06	1836800.00	1836800.00	100.00
FPDC	.01	151487.00	151487.00	100.00
FPDC	.06	177178.00	177178.00	100.00
FPDD	.01	1299497.00	1299497.00	100.00
FPDE	.01	1955038.00	1955038.00	100.00
FPDE	.02	2991210.00	2991210.00	100.00
FPDF	.01	57490.00	57490.00	100.00
FPDG	.01	380760.00	380760.00	100.00
FPDH	.01	113396.00	113396.00	100.00
FPDH	.04	338806.00	338806.00	100.00
FPDK	.01	302775.00	302775.00	100.00
FPDL	.01	550448.00	550448.00	100.00
FPDM	.01	361453.00	361453.00	100.00
FPDP	.01	1276581.00	1276581.00	100.00
FPDQ	.01	11527.00	11527.00	100.00
FPDQ	.02	650800.00	650800.00	100.00
FPEA	.01	609387.00	609387.00	100.00
FPEA	.02	129000.00	129000.00	100.00
FPED	.01	375000.00	375000.00	100.00
FPED	.04	487089.00	487089.00	100.00
FPEE	.01	194949.00	194949.00	100.00
FPEE	.02	299435.00	299435.00	100.00
FPEF	.01	295201.00	295201.00	100.00
FPEG	.01	1458705.00	1458705.00	100.00
FPEG	.04	120300.00	120300.00	100.00
FPEH	.01	115877.00	115877.00	100.00
FPEH	.04	76700.00	76700.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
FPEL	.02	5313792.00	5313792.00	100.00
FPEL	.05	1728400.00	1728400.00	100.00
FPEM	.01	1643.00	1643.00	100.00
FPEN	.04	76396.00	76396.00	100.00
FPEP	.01	286416.00	286416.00	100.00
FPEP	.06	43051.00	43051.00	100.00
FPEQ	.01	1386270.00	1386270.00	100.00
FPFB	.01	404080.00	404080.00	100.00
FPFC	.01	38862.00	38862.00	100.00
FPFJ	.01	327350.00	327350.00	100.00
FPFK	.01	287752.00	287752.00	100.00
FPFL	.01	705731.00	705731.00	100.00
FPFM	.01	86183.00	86183.00	100.00
FPFM	.05	66369.00	66369.00	100.00
FPFP	.01	550900.00	550900.00	100.00
FPHC	.01	3834052.00	3834052.00	100.00
FPHD	.01	1068.00	1068.00	100.00
FPHE	.01	213334.00	213334.00	100.00
FPHE	.02	389091.00	389091.00	100.00
FPHE	.03	79300.00	79300.00	100.00
FPJA	.01	1036806.00	1036806.00	100.00
FPJA	.02	1774463.00	1774463.00	100.00
FPJA	.04	22491.00	22491.00	100.00
FPJB	.01	695968.00	695968.00	100.00
FPJB	.02	829504.00	829504.00	100.00
FPJB	.04	44016.00	44016.00	100.00
FPJB	.06	582917.00	582917.00	100.00
FPJC	.01	8278850.00	8278850.00	100.00
FPJC	.02	3232000.00	3232000.00	100.00
FPJC	.04	22491.00	22491.00	100.00
FPJC	.06	548523.00	548523.00	100.00
FPLB	.01	2806215.00	2806215.00	100.00
FPLC	.01	697355.00	697355.00	100.00
FPLE	.01	179761.00	179761.00	100.00
FPLF	.01	4609083.00	4609083.00	100.00
FPLF	.04	254414.00	254414.00	100.00
FPLF	.06	1778500.00	1778500.00	100.00
FPLG	.01	313500.00	313500.00	100.00
FPLG	.02	1896100.00	1896100.00	100.00
FPLK	.01	700983.00	700983.00	100.00
FPLK	.04	1341264.00	1341264.00	100.00
FPLX	.01	4443561.00	4443561.00	100.00
FPLZ	.01	2727368.00	2727368.00	100.00
FPMA	.01	630283.00	630283.00	100.00
FPMB	.01	188462.00	188462.00	100.00
FPMC	.01	727672.00	727672.00	100.00
FPMC	.05	143700.00	143700.00	100.00
FPMD	.01	2047320.00	2047320.00	100.00
FPMH	.02	2222819.00	2222819.00	100.00
FPMH	.03	817162.00	817162.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
FPMJ	.01	1512332.00	1512332.00	100.00
FPMJ	.05	144835.00	144835.00	100.00
FPMK	.01	666772.00	666772.00	100.00
FPMK	.04	232000.00	232000.00	100.00
FPMK	.06	502553.00	502553.00	100.00
FPMM	.01	2048522.00	2048522.00	100.00
FPMM	.04	1332600.00	1332600.00	100.00
FPNA	.01	5256118.00	5256118.00	100.00
FPNC	.01	527576.00	527576.00	100.00
FPNC	.03	1795000.00	1795000.00	100.00
FPNE	.02	239022.00	239022.00	100.00
FPNE	.05	692100.00	692100.00	100.00
FPNF	.01	1095678.00	1095678.00	100.00
FPNG	.01	416157.00	416157.00	100.00
FPNH	.01	3700.00	3700.00	100.00
FPSA	.01	746814.00	746814.00	100.00
FPSA	.06	6052849.00	6052849.00	100.00
FPSB	.01	365506.00	365506.00	100.00
FPSB	.04	1052000.00	1052000.00	100.00
FPSF	.01	2923196.00	2923196.00	100.00
FPSG	.01	6015816.00	6015816.00	100.00
FPSH	.01	2642575.00	2642575.00	100.00
FPSL	.01	8639900.00	8639900.00	100.00
FPWB	.01	1929687.00	1929687.00	100.00
FPWB	.06	1406353.00	1406353.00	100.00
FPWC	.01	179790.00	179790.00	100.00
FPWC	.04	15591.00	15591.00	100.00
FPWC	.05	73831.00	73831.00	100.00
FPWC	.06	123949.00	123949.00	100.00
FPWD	.04	44383.00	44383.00	100.00
FPXK	.02	708651.00	708651.00	100.00
FPXX	.01	2224850.00	2224850.00	100.00
FPXX	.06	38133.00	38133.00	100.00
FS01	.01	90000.00	90000.00	100.00
LARM	.01	107900.00	107900.00	100.00
LONG	.01	831080.00	831080.00	100.00
MPKA	.01	277245.00	277245.00	100.00
MPTK	.01	132396.00	132396.00	100.00
MPTL	.01	108036.00	108036.00	100.00
MPTM	.01	383716.00	383716.00	100.00
MS2B	.01	109344.00	109344.00	100.00
MS5S	.01	7829.00	7829.00	100.00
MT1A	.01	44357.00	44357.00	100.00
MT1D	.01	120000.00	120000.00	100.00
MT1G	.01	503964.00	503964.00	100.00
MT1L	.01	603161.00	603161.00	100.00
MT5Y	.01	131841.00	131841.00	100.00
MX5T	.01	809348.00	809348.00	100.00
NEW	.01	5565000.00	5565000.00	100.00
PEWE	.01	301183.00	301183.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
RA02	.01	88255.00	88255.00	100.00
RA11	.01	138363.00	138363.00	100.00
RA11	.04	714684.00	714684.00	100.00
RA11	.06	28000.00	28000.00	100.00
RA14	.01	53450.00	53450.00	100.00
RA18	.01	974734.00	974734.00	100.00
RA31	.01	872765.00	872765.00	100.00
RA31	.06	129614.00	129614.00	100.00
RB04	.01	67822.00	67822.00	100.00
RB07	.01	58440.00	58440.00	100.00
RB12	.01	29900.00	29900.00	100.00
RB14	.01	5116.00	5116.00	100.00
RB16	.01	40000.00	40000.00	100.00
RB21	.01	4635.00	4635.00	100.00
RB25	.01	437000.00	437000.00	100.00
RC01	.02	10166.00	10166.00	100.00
RC02	.01	98472.00	98472.00	100.00
RC04	.01	1270900.00	1270900.00	100.00
RD06	.01	5412000.00	5412000.00	100.00
RD07	.01	57000.00	57000.00	100.00
RD07	.04	195979.00	195979.00	100.00
RD12	.01	49500.00	49500.00	100.00
RD12	.02	37466.00	37466.00	100.00
RD13	.01	605042.00	605042.00	100.00
RD15	.01	184663.00	184663.00	100.00
RD16	.01	181368.00	181368.00	100.00
RD17	.01	124436.00	124436.00	100.00
RD18	.01	484525.00	484525.00	100.00
RD19	.01	1768800.00	1768800.00	100.00
RD22	.01	37200.00	37200.00	100.00
RE02	.01	147100.00	147100.00	100.00
RF02	.01	727708.00	727708.00	100.00
RF02	.02	149807.00	149807.00	100.00
RF03	.01	135000.00	135000.00	100.00
RF03	.04	23100.00	23100.00	100.00
RF03	.06	447600.00	447600.00	100.00
RF06	.01	134358.00	134358.00	100.00
RF07	.01	46020.00	46020.00	100.00
RF09	.01	200826.00	200826.00	100.00
RF09	.06	244300.00	244300.00	100.00
RFAM	.01	630675.00	630675.00	100.00
RG03	.01	627637.00	627637.00	100.00
RG04	.01	2000578.00	2000578.00	100.00
RG05	.01	385630.00	385630.00	100.00
RG06	.01	689985.00	689985.00	100.00
RG06	.02	1610.00	1610.00	100.00
RG06	.03	108600.00	108600.00	100.00
RH09	.01	91187.00	91187.00	100.00
RH12	.01	48489.00	48489.00	100.00
RH12	.04	72800.00	72800.00	100.00

		TOTASPIRE	TOTFUND	PCT-FUNDED
RH13	.01	1276.00	1276.00	100.00
RH13	.04	31327.00	31327.00	100.00
RJ40	.01	221980.00	221980.00	100.00
RJC0	.01	138889.00	138889.00	100.00
RJC5	.01	211222.00	211222.00	100.00
RJC6	.01	449496.00	449496.00	100.00
RJC7	.01	688031.00	688031.00	100.00
RJC9	.01	633803.00	633803.00	100.00
RJCA	.01	708374.00	708374.00	100.00
RJCB	.01	24963.00	24963.00	100.00
RJL4	.01	204169.00	204169.00	100.00
RJL4	.02	233000.00	233000.00	100.00
RJL5	.01	31102.00	31102.00	100.00
RJL6	.01	7984.00	7984.00	100.00
RJL7	.01	354014.00	354014.00	100.00
RJL8	.01	351673.00	351673.00	100.00
RJM1	.01	1966219.00	1966219.00	100.00
RJM2	.01	700710.00	700710.00	100.00
RJM3	.01	555.00	555.00	100.00
RJS1	.01	1564783.00	1564783.00	100.00
RJS2	.01	84047.00	84047.00	100.00
RJS2	.05	233815.00	233815.00	100.00
RJT0	.01	39900.00	39900.00	100.00
RJT3	.01	67035.00	67035.00	100.00
RJT7	.01	36873.00	36873.00	100.00
RJT8	.01	158830.00	158830.00	100.00
RJT9	.01	79731.00	79731.00	100.00
RK1X	.03	23000.00	23000.00	100.00
TA18	.01	3253.00	3253.00	100.00
TA18	.04	42289.00	42289.00	100.00
TA35	.04	21772.00	21772.00	100.00
XXX3	.01	40500.00	40500.00	100.00
TOTAL.FUNDED		2.606806E+8	1.776873E+8	68.16

— 1128 PARAMETER UNFUNDREP Summary Report of Unfunded Projects

		WARVAL	TOTASPIRE	UNFUNDED
FL6X	.01	3.52	98700.00	1.00
FL6X	.02	0.44	111500.00	1.00
FPGA	.01	48.50	35381174.00	1.00
FPGA	.02	45.45	1905700.00	1.00
FPHB	.01	3.52	620551.00	1.00
FPLK	.02	0.80	1253500.00	1.00
FPNB	.01	25.80	1300461.00	1.00
FPSD	.01	6.86	4385149.00	1.00
FPSD	.04	0.29	1381651.00	1.00
FPSD	.06	0.29	3496890.00	1.00
FPSE	.01	15.64	717622.00	1.00
FPSE	.02	4.44	17100303.00	1.00
FPSJ	.01	1.62	12909581.00	1.00
RA08	.01	3.23	256148.00	1.00
RA08	.06	0.16	1086904.00	1.00
RA09	.01	3.23	127800.00	1.00
RA09	.02	0.20	11347.00	1.00
RF01	.01	1.61	240053.00	1.00
RF08	.01	1.67	608248.00	1.00
TOTAL.UNFUNDED		167.27	82993282.00	19.00

— 1148 PARAMETER EXCLUDREP Summary Report of Excluded Projects

		WARVAL	TOTASPIRE	EXCLUDED
ACE3	.01	3.84		1.00
FL6V	.01	2.84		1.00
FPED	.02	3.03	305349.00	1.00
FPEL	.01	4.86		1.00
FPEN	.01	6.07		1.00
FPMH	.01	3.36		1.00
FPNE	.01	2.84		1.00
FPWD	.01	1.28		1.00
FPXK	.01	0.68		1.00
FTMD	.01	6.80		1.00
RB03	.01	8.36		1.00
RB08	.01	0.15		1.00
RC01	.01	2.55		1.00
RJL3	.01	2.27		1.00
RJT2	.01	2.31		1.00
TA35	.01	1.44		1.00
TOTAL.EXCLUDED		52.68	305349.00	16.00

— 1168 PARAMETER MISNREP Funding Report by Mission Area as Per Cent of Budget

INDEX 1 = FY94

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.22	
C2	1.00	3.00	6.00	1.19	
IEW	3.00	6.00	9.00	3.69	
EMW	1.00	3.00	6.00	1.06	
AD	2.00	4.00	8.00	5.86	
FS	10.00	16.00	20.00	8.81	-1.19
CSS	10.00	14.00	20.00	8.56	-1.44
AVN	12.00	20.00	30.00	9.21	-2.79
CCL	5.00	9.00	15.00	3.15	-1.85
CCH	8.00	13.00	18.00	4.91	-3.09
NBC	2.00	4.00	7.00	1.52	-0.48
UNSPENT				46.00	

INDEX 1 = FY95

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.31	
C2	1.00	3.00	6.00	1.27	
IEW	3.00	6.00	9.00	3.07	
EMW	1.00	3.00	6.00	1.34	
AD	2.00	4.00	8.00	6.10	
FS	10.00	16.00	20.00	10.55	
CSS	10.00	14.00	20.00	7.73	-2.27
AVN	12.00	20.00	30.00	9.54	-2.46
CCL	5.00	9.00	15.00	3.65	-1.35
CCH	8.00	13.00	18.00	7.65	-0.35
NBC	2.00	4.00	7.00	1.32	-0.68
UNSPENT				41.00	

INDEX 1 = FY96

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	8.65	
C2	1.00	3.00	6.00	1.62	
IEW	3.00	6.00	9.00	3.52	
EMW	1.00	3.00	6.00	1.51	
AD	2.00	4.00	8.00	6.71	
FS	10.00	16.00	20.00	11.21	
CSS	10.00	14.00	20.00	10.84	
AVN	12.00	20.00	30.00	7.84	-4.16
CCL	5.00	9.00	15.00	3.68	-1.32
CCH	8.00	13.00	18.00	8.96	

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
NBC	2.00	4.00	7.00	1.61	-0.39
UNSPENT				34.00	

INDEX 1 = FY97

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.54	
C2	1.00	3.00	6.00	1.52	
IEW	3.00	6.00	9.00	3.16	
EMW	1.00	3.00	6.00	1.40	
AD	2.00	4.00	8.00	6.71	
FS	10.00	16.00	20.00	10.68	
CSS	10.00	14.00	20.00	11.07	
AVN	12.00	20.00	30.00	6.03	-5.97
CCL	5.00	9.00	15.00	4.03	-0.97
CCH	8.00	13.00	18.00	10.11	
NBC	2.00	4.00	7.00	1.50	-0.50
UNSPENT				37.00	

INDEX 1 = FY98

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.58	
C2	1.00	3.00	6.00	1.35	
IEW	3.00	6.00	9.00	3.81	
EMW	1.00	3.00	6.00	1.83	
AD	2.00	4.00	8.00	6.06	
FS	10.00	16.00	20.00	12.14	
CSS	10.00	14.00	20.00	10.11	
AVN	12.00	20.00	30.00	8.32	-3.68
CCL	5.00	9.00	15.00	4.26	-0.74
CCH	8.00	13.00	18.00	12.13	
NBC	2.00	4.00	7.00	1.06	-0.94
UNSPENT				32.00	

INDEX 1 = FY99

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.61	
C2	1.00	3.00	6.00	1.35	
IEW	3.00	6.00	9.00	3.27	
EMW	1.00	3.00	6.00	1.95	
AD	2.00	4.00	8.00	5.31	
FS	10.00	16.00	20.00	12.56	

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
CSS	10.00	14.00	20.00	10.49	
AVN	12.00	20.00	30.00	9.73	-2.27
CCL	5.00	9.00	15.00	4.27	-0.73
CCH	8.00	13.00	18.00	11.82	
NBC	2.00	4.00	7.00	1.14	-0.85
UNSPENT				31.00	

INDEX 1 = FY00

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	4.89	
C2	1.00	3.00	6.00	1.18	
IEW	3.00	6.00	9.00	3.11	
EMW	1.00	3.00	6.00	1.92	
AD	2.00	4.00	8.00	3.97	
FS	10.00	16.00	20.00	12.98	
CSS	10.00	14.00	20.00	11.05	
AVN	12.00	20.00	30.00	10.96	-1.04
CCL	5.00	9.00	15.00	3.85	-1.15
CCH	8.00	13.00	18.00	8.65	
NBC	2.00	4.00	7.00	1.16	-0.84
UNSPENT				36.00	

INDEX 1 = FY01

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	4.67	
C2	1.00	3.00	6.00	0.71	-0.29
IEW	3.00	6.00	9.00	3.28	
EMW	1.00	3.00	6.00	1.80	
AD	2.00	4.00	8.00	3.90	
FS	10.00	16.00	20.00	13.44	
CSS	10.00	14.00	20.00	11.97	
AVN	12.00	20.00	30.00	9.25	-2.75
CCL	5.00	9.00	15.00	2.84	-2.16
CCH	8.00	13.00	18.00	8.41	
NBC	2.00	4.00	7.00	1.32	-0.68
UNSPENT				38.00	

INDEX 1 = FY02

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.14	
C2	1.00	3.00	6.00	0.67	-0.33
IEW	3.00	6.00	9.00	3.24	
EMW	1.00	3.00	6.00	2.19	
AD	2.00	4.00	8.00	4.08	
FS	10.00	16.00	20.00	15.04	
CSS	10.00	14.00	20.00	10.82	
AVN	12.00	20.00	30.00	8.76	-3.24
CCL	5.00	9.00	15.00	2.84	-2.16
CCH	8.00	13.00	18.00	4.28	-3.72
NBC	2.00	4.00	7.00	0.99	-1.01
UNSPENT				40.00	

INDEX 1 = FY03

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	7.70	
C2	1.00	3.00	6.00	0.67	-0.33
IEW	3.00	6.00	9.00	4.88	
EMW	1.00	3.00	6.00	2.20	
AD	2.00	4.00	8.00	4.28	
FS	10.00	16.00	20.00	13.60	
CSS	10.00	14.00	20.00	9.38	-0.62
AVN	12.00	20.00	30.00	8.52	-3.48
CCL	5.00	9.00	15.00	2.73	-2.27
CCH	8.00	13.00	18.00	3.94	-4.06
NBC	2.00	4.00	7.00	1.26	-0.74
UNSPENT				41.00	

INDEX 1 = FY04

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	4.49	
C2	1.00	3.00	6.00	0.65	-0.35
IEW	3.00	6.00	9.00	5.77	
EMW	1.00	3.00	6.00	2.61	
AD	2.00	4.00	8.00	3.89	
FS	10.00	16.00	20.00	10.67	
CSS	10.00	14.00	20.00	9.39	-0.61
AVN	12.00	20.00	30.00	8.42	-3.58
CCL	5.00	9.00	15.00	2.85	-2.15
CCH	8.00	13.00	18.00	3.56	-4.44
NBC	2.00	4.00	7.00	1.29	-0.71
UNSPENT				46.00	

INDEX 1 = FY05

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.54	
C2	1.00	3.00	6.00	0.30	-0.70
IEW	3.00	6.00	9.00	3.78	
EMW	1.00	3.00	6.00	2.32	
AD	2.00	4.00	8.00	3.33	
FS	10.00	16.00	20.00	10.95	
CSS	10.00	14.00	20.00	9.56	-0.44
AVN	12.00	20.00	30.00	9.07	-2.93
CCL	5.00	9.00	15.00	2.23	-2.77
CCH	8.00	13.00	18.00	5.07	-2.93
NBC	2.00	4.00	7.00	1.27	-0.73
UNSPENT				46.00	

INDEX 1 = FY06

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.65	
C2	1.00	3.00	6.00	0.30	-0.70
IEW	3.00	6.00	9.00	2.78	-0.22
EMW	1.00	3.00	6.00	2.32	
AD	2.00	4.00	8.00	4.05	
FS	10.00	16.00	20.00	8.36	-1.64
CSS	10.00	14.00	20.00	9.65	-0.35
AVN	12.00	20.00	30.00	8.57	-3.43
CCL	5.00	9.00	15.00	1.81	-3.19
CCH	8.00	13.00	18.00	7.34	-0.66
NBC	2.00	4.00	7.00	1.33	-0.66
UNSPENT				47.00	

INDEX 1 = FY07

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.69	
C2	1.00	3.00	6.00	0.22	-0.78
IEW	3.00	6.00	9.00	3.20	
EMW	1.00	3.00	6.00	2.23	
AD	2.00	4.00	8.00	1.62	-0.38
FS	10.00	16.00	20.00	7.88	-2.12
CSS	10.00	14.00	20.00	8.86	-1.14
AVN	12.00	20.00	30.00	8.75	-3.25
CCL	5.00	9.00	15.00	1.55	-3.45
CCH	8.00	13.00	18.00	10.99	
NBC	2.00	4.00	7.00	1.29	-0.71
UNSPENT				47.00	

INDEX 1 = FY08

	MINIMUM	DESIRED	MAXIMUM	ACTUAL	DEVIATION
COM	4.00	8.00	12.00	6.54	
C2	1.00	3.00	6.00	0.23	-0.77
IEW	3.00	6.00	9.00	3.00	-3.00000E-4
EMW	1.00	3.00	6.00	1.36	
AD	2.00	4.00	8.00	2.12	
FS	10.00	16.00	20.00	8.00	-2.00
CSS	10.00	14.00	20.00	8.70	-1.30
AVN	12.00	20.00	30.00	7.93	-4.07
CCL	5.00	9.00	15.00	1.55	-3.45
CCH	8.00	13.00	18.00	11.28	
NBC	2.00	4.00	7.00	1.01	-0.98
UNSPENT				48.00	

— 1179 PARAMETER TURBREP Report of Funding Turbulence

(ALL 0.000)

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